ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021

B.TECH. CHEMICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

1. **PROGRAMME OUTCOMES (POs)**:

After going through the four years of study, our Chemical Engineering Graduates will exhibit ability to:

	Graduate attribute	Programme Outcome
PO1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	Problem analysis	Problem analysis Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design / development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage	Modern tool usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
PO6	The Engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in

		multidisciplinary settings.
PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

2. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Chemical Engineering Programme the student will have following Program-specific outcomes.

1. Graduates will have a strong foundation in engineering, science and current Chemical Engineering practices and will have experience in solving structured and unstructured problems using conventional and innovative solutions.
2. Graduates will be able to effectively describe the Chemical Engineering problem, analyze the data, develop potential solutions, evaluate these solutions, and present the results using their oral, written and electronic media skills.
3. Graduates will have an understanding of ethical and professional responsibilities of an engineer and the impact of engineering solutions on society and the global environment.

3. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
YEAR 1	SEMESTER 1	Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-
		Engineering Chemistry	2.8	1.3	1.6	1	-	1.5	1.8	-		-	-	1.5	-	-	-
		Problem Solving and Python Programming	2	3	3	3	2	-	-	-	-	-	2	2	3	3	
		தமிழர் மரபு /Heritage of Tamils															
		Problem Solving and Python Programming Laboratory	2	3	3	3	2	-	-	-	-	-	2	2	3	3	
		Physics and Chemistry Laboratory	3	2.4	2.6	1	1										
			2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-
		English Laboratory	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
	SEMSTER 2	Professional English – II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
		Physics of Materials	3	2.25	2	1.66	2	1.6	1.75	1				1			
		Basic Electrical, Electronics and Instrumentation Engineering	2	1	1					1					-	-	-
		Engineering Graphics	3	1	2		2					3		2	2	2	
		Introduction to Chemical Engineering	3	2	3	1	1	1	1	1	-	-	1	1	2	2	-
		தமிழரும் தொழில்நுட் பமும் / Tamils and Technology															
		Engineering Practices Laboratory	3	2			1	1	1					2	2	1	1
		Basic Electrical, Electronics and Instrumentation Engineering Laboratory	1.6	1.4	0.8	1.6				1.2	1.6						
		Communication Laboratory / Foreign Language	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

YEAR 2	SEMESTER 3	Differential Equations	3	3	2.4	1.8	1.6	1	0.4	0	0.4	0.2	0.6	1.6	2	1.2	1
		Basic Mechanical Engineering	3	3	3	2	2	2	1	2	2	2	2	3	2	2	2
		Mechanics of Solids	2	2	3	2	2	2	1	2	2	2	2	3	2	2	2
		Chemical Process Calculations	3	3	2	2	2	2	1	1	3	2	2	3	3	3	2
		Fluid Mechanics for Chemical Engineers	3	3	3	3	3	2	3	2	1	1	2	3	3	3	3
		Chemical Process Industries	3	2	3	2	3	1	-	1	1	1	1	1	2	2	2
		Basic Mechanical Engineering Laboratory	3	3	3	3	2	2	2	3	2	3	2	2	3	3	2
		Technical Analysis Laboratory	1	3	3	3	2	2	2	3	2	3	2	2	3	3	1
	SEMESTER 4	Transform Techniques	3	2.8	2.2	1.6	0.8	0.6	0.8	0.2	0.6	0.2	2	0.2	2.2	1.8	1.4
		Mass Transfer I	3	3	3	-	-	1	1	1	-	-	-	3	2	1	-
		Mechanical Operations	3	3	3	3	1	1	1	-	3	3	3	2	3	3	1
		Chemical Engineering Thermodynamics-I	3	3	2	2	2	2	2	2	3	2	2	2	2	2	2
		Heat Transfer	2	3	3	2	2	1	1	1	1	1	1	2	2	2	2
		Environmental Science and Sustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-
		Fluid Mechanics Laboratory	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3
		Mechanical Operations Laboratory	3	3	2	2	2	2	3	2	3	2	2	2	3	3	2
YEAR 3	SEMESTER 5	Mass Transfer II	3	3	2	-	-	1	1	1	-	1	-	3	3	2	2
		Chemical Engineering Thermodynamics –II	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
		Computational Chemical Engineering Laboratory	3	3	3	3	3	-	2	1	1	-	-	-	3	3	-
		Heat Transfer Laboratory	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
		Mass Transfer Laboratory	3	3	-	3	-	-	-	-	2	-	-	2	3	3	-
	SEMESTER 6	Chemical Reaction Engineering-I	3	3	3	2	2	2	2	-	-	-	-	-	3	3	-
		Process Dynamics and Control	3	3	3	3	2	2	3	-	2	2	2	2	3	3	1
		Chemical	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-

		Reaction Engineering Laboratory															
		Process Equipment design and drawing	3	3	3	2	2	3	3	-	2	2	2	2	3	3	2
YEAR 4	**SEMEST**	Chemical Reaction Engineering-II	3	3	3	3	2	2	2	-	-	-	-	3	3	3	-
		Transport Phenomena	3	3	3	2	1	-	-	-	1	-	-	1	3	3	-

1-Low,2-Medium,3-High,”-“-no correlation

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B.TECH. CHEMICAL ENGINEERING
CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3152	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory $	EEC	0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

$ Skill Based Course

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	HS3252	Professional English – II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical	BSC	3	1	0	4	4
3.	PH3258	Physics of Materials	BSC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	CH3251	Introduction to Chemical Engineering	PCC	3	0	0	3	3
7.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1#	-	2	0	0	2	2
PRACTICALS								
9.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	2	2
10.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	2	2
11.	GE3272	Communication Laboratory / Foreign Language $	EEC	0	0	4	4	2
			TOTAL	**17**	**1**	**16**	**30**	**26**

NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
$ Skill Based Course

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA3356	Differential Equations	BSC	3	1	0	4	4
2.	CH3301	Basic Mechanical Engineering	ESC	3	0	0	3	3
3.	CH3302	Mechanics of Solids	ESC	3	0	0	3	3
4.	CH3351	Chemical Process Calculations	PCC	3	0	0	3	3
5.	CH3352	Fluid Mechanics for Chemical Engineers	PCC	3	0	0	3	3
6.	CH3303	Chemical Process Industries	PCC	3	0	0	3	3
PRACTICALS								
7.	CH3311	Basic Mechanical Engineering Laboratory	ESC	0	0	3	3	1.5
8.	CH3312	Technical Analysis Laboratory	PCC	0	0	3	3	1.5
9.	GE3361	Professional Development$	EEC	0	0	2	2	1
			TOTAL	**18**	**1**	**8**	**27**	**23**

$ Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA3451	Transform Techniques	BSC	3	1	0	4	4
2.	CH3451	Mass Transfer I	PCC	3	0	0	3	3
3.	PC3352	Mechanical Operations	PCC	3	0	0	3	3
4.	CH3401	Chemical Engineering Thermodynamics – I	PCC	3	0	0	3	3
5.	CH3491	Heat Transfer	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2#		3	0	0	3	3 #
PRACTICALS								
8.	CH3411	Fluid Mechanics Laboratory	PCC	0	0	3	3	1.5
9.	CH3412	Mechanical Operations Laboratory	PCC	0	0	3	3	1.5
10.	CH3513	Industrial Training/ Internship I*	EEC	-	-	-	-	-
			TOTAL	**17**	**1**	**6**	**24**	**21**

\# NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

*Two weeks industrial training/internship carries one credit. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	CH3501	Chemical Engineering Thermodynamics – II	PCC	3	0	0	3	3
2.	CH3551	Mass Transfer II	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Mandatory Course-I&	MC	3	0	0	3	Non-Credit Course
PRACTICALS								
7.	CH3511	Computational Chemical Engineering Laboratory	PCC	0	0	3	3	1.5
8.	CH3512	Heat Transfer Laboratory	PCC	0	0	3	3	1.5
9.	CH3561	Mass Transfer Laboratory	PCC	0	0	3	3	1.5
10.	CH3513	Industrial Training/Internship I*	EEC	-	-	-	-	1
			TOTAL	**18**	**0**	**9**	**27**	**20.5**

& Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)
*Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	CH3601	Chemical Reaction Engineering – I	PCC	3	0	0	3	3
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.	CH3651	Process Dynamics and Control	PCC	3	0	0	3	3
7.		NCC Credit Course Level 3#		3	0	0	3	3 #
8.		Mandatory Course-II&	MC	3	0	0	3	Non-Credit Course
PRACTICALS								
9.	CH3611	Chemical Reaction Engineering Laboratory	PCC	0	0	3	3	1.5
10.	CH3612	Process Equipment Design and Drawing	PCC	0	0	3	3	1.5
11.	CH3712	Industrial Training/ Internship II##	EEC	-	-	-	-	-
			TOTAL	**21**	**0**	**6**	**27**	**21**

*Open Elective – I shall be chosen from the emerging technologies.
##Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester
& Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)
# NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER VII/VIII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	CH3701	Chemical Reaction Engineering II	PCC	3	0	0	3	3
2.	CH3702	Transport Phenomena	PCC	3	0	0	3	3
3.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
4.		Elective - Management #	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICALS								
8.	CH3711	Process Control Laboratory	PCC	0	0	3	3	1.5
9.	CH3712	Industrial Training / Internship II##	EEC	-	-	-	-	1
			TOTAL	**20**	**0**	**3**	**23**	**22.5**

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

Elective- Management shall be chosen from the Elective Management courses

##Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

SEMESTER VIII/VII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
PRACTICALS								
1.	CH3811	Project Work / Internship#	EEC	0	0	20	20	10
			TOTAL	**0**	**0**	**20**	**20**	**10**

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

#15 weeks of continuous Internship in an organization carries 10 credits.

TOTAL CREDITS: 166

ELECTIVE – MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

MANDATORY COURSES I*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS
				L	T	P	
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3
2.	MX3082	Elements of Literature	MC	3	0	0	3
3.	MX3083	Film Appreciation	MC	3	0	0	3
4.	MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3

* Mandatory Courses are offered as Non –Credit Courses

MANDATORY COURSES II*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS
				L	T	P	
1.	MX3085	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MC	3	0	0	3
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3
5.	MX3089	Industrial Safety	MC	3	0	0	3

* Mandatory Courses are offered as Non –Credit Courses

PROFESSIONAL ELECTIVE COURSES : VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computational Chemical Engineering	Vertical VI Chemical Plant Design
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Air Pollution Engineering	Computational Techniques	Chemical Plant Design
Primary Refining Technology	Renewable Energy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Plant Layout
Secondary Refining Technology	Pinch Technology	Fermentation and Bioprocessing	Solid waste Management	Process Modeling and Simulation	Design Safety
Refinery Advancements and Environmental Regulations	Hydrogen And Fuel Cell Technology	Bio separation and Downstream Processing	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection
Petroleum Equipment Design	Power Plant Engineering	Enzyme Immobilisation Technology	Process Safety Management	Chemical Process Flow sheeting	Statutory Requirements and Customer Care
Petrochemical Technology	Non-Renewable Energy Sources	Bioreactor Design	Risk and HAZOP Analysis	Computational Fluid Dynamics	Process Plant Utilities

Registration of Professional Elective Courses from Verticals:

Refer to the regulations 2021, Clause 6.3. (Amended on 27.07.2023)

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL I: PETROLEUM PROCESS TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CH3001	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3
2.	CH3002	Primary Refining Technology	PEC	3	0	0	3	3
3.	CH3003	Secondary Refining Technology	PEC	3	0	0	3	3
4.	CH3004	Refinery Advancements and Environmental Regulations	PEC	3	0	0	3	3
5.	PE3591	Petroleum Equipment Design	PEC	3	0	0	3	3
6.	CH3005	Petrochemical Technology	PEC	3	0	0	3	3

VERTICAL II: ENERGY ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CH3006	Bioenergy	PEC	3	0	0	3	3
2.	CH3007	Renewable Energy Resources	PEC	3	0	0	3	3
3.	CH3008	Pinch Technology	PEC	3	0	0	3	3
4.	CH3009	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3
5.	CH3010	Power Plant Engineering	PEC	3	0	0	3	3
6.	CH3011	Non-Renewable Energy Sources	PEC	3	0	0	3	3

VERTICAL III: BIOCHEMICAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	BT3392	Biochemistry	PEC	3	0	0	3	3
2.	CH3012	Bioprocess Technology	PEC	3	0	0	3	3
3.	CH3013	Fermentation and Bioprocessing	PEC	3	0	0	3	3
4.	CH3014	Bioseparation and Downstream Processing	PEC	3	0	0	3	3
5.	CH3015	Enzyme Immobilisation Technology	PEC	3	0	0	3	3
6.	CH3016	Bioreactor Design	PEC	3	0	0	3	3

VERTICAL IV ENVIRONMENTAL AND SAFETY ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CH3017	Air Pollution Engineering	PEC	3	0	0	3	3
2.	CH3018	Waste Water Treatment	PEC	3	0	0	3	3
3.	CH3019	Solid waste Management	PEC	3	0	0	3	3
4.	CH3020	Environmental Impact Assessment	PEC	3	0	0	3	3
5.	CH3021	Process Safety Management	PEC	3	0	0	3	3
6.	CH3022	Risk and HAZOP Analysis	PEC	3	0	0	3	3

VERTICAL V: COMPUTATIONAL CHEMICAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CH3023	Computational Techniques	PEC	3	0	0	3	3
2.	CH3024	Optimization of Chemical Processes	PEC	3	0	0	3	3
3.	CCH331	Process Modeling and Simulation	PEC	3	0	0	3	3
4.	CH3025	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3
5.	CH3026	Chemical Process Flow sheeting	PEC	3	0	0	3	3
6.	CH3027	Computational Fluid Dynamics	PEC	3	0	0	3	3

VERTICAL VI: CHEMICAL PLANT DESIGN

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CH3028	Chemical Plant Design	PEC	3	0	0	3	3
2.	CH3029	Plant Layout	PEC	3	0	0	3	3
3.	CH3030	Design Safety	PEC	3	0	0	3	3
4.	CH3031	Material Selection	PEC	3	0	0	3	3
5.	CH3032	Statutory Requirements and Customer Care	PEC	3	0	0	3	3
6.	CH3033	Process Plant Utilities	PEC	3	0	0	3	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	CCS333	Augmented Reality /Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
7.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
8.	OPR351	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	AU3791	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
17.	OAE352	Fundamentals of	OEC	3	0	0	3	3

		Aeronautical engineering						
18.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
19.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
23.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
24.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
25.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
26.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
27.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
28.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
29.	OEC351	Signals and Systems	OEC	3	0	0	3	3
30.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
31.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
32.	CBM333	Assistive Technology	OEC	3	0	0	3	3
33.	OMA352	Operations Research	OEC	3	0	0	3	3
34.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
35.	OMA354	Linear Algebra	OEC	3	0	0	3	3
36.	OBT352	Basics of Microbial Technology	OEC	3	0	0	3	3
37.	OBT353	Basics of Biomolecules	OEC	3	0	0	3	3
38.	OBT354	Fundamentals of Cell and Molecular Biology	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
5.	OCE354	Basics of Integrated Water Resources	OEC	3	0	0	3	3

		Management						
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	CME343	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	3	0	0	3	3
11.	MF3010	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	AU3002	Batteries and Management system	OEC	3	0	0	3	3
14.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
21.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
22.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Concepts in Mobile Robots	OEC	3	0	0	3	3
25.	MV3501	Marine Propulsion	OEC	3	0	0	3	3
26.	OMV351	Marine Merchant Vessels	OEC	3	0	0	3	3
27.	OMV352	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	CRA332	Drone Technologies	OEC	3	0	0	3	3
29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
32.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
33.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3

34.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
35.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
36.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
37.	FT3201	Fibre Science	OEC	3	0	0	3	3
38.	OTT355	Garment Manufacturing Technology	OEC	3	0	0	3	3
39.	OPE353	Industrial safety	OEC	3	0	0	3	3
40.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
41.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
42.	OEC353	VLSI Design	OEC	3	0	0	3	3
43.	CBM370	Wearable devices	OEC	3	0	0	3	3
44.	CBM356	Medical Informatics	OEC	3	0	0	3	3
45.	OBT355	Biotechnology for Waste Management	OEC	3	0	0	3	3
46.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
47.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

SUMMARY

B.TECH. CHEMICAL ENGINEERING										
S.No	**Subject Area**	**Credits per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII/VIII**	**VIII/VII**	
1	**HSMC**	**4**	**3**					**5**		**12**
2	**BSC**	**12**	**7**	**4**	**6**					**29**
3	**ESC**	**5**	**11**	**7.5**						**23.5**
4	**PCC**		**3**	**10.5**	**15**	**10.5**	**9**	**7.5**		**55.5**
5	**PEC**					**9**	**9**			**18**
6	**OEC**						**3**	**9**		**12**
7	**EEC**	**1**	**2**	**1**		**1**		**1**	**10**	**16**
8	**Non-Credit /(Mandatory)**					√	√			
Total		**22**	**26**	**23**	**21**	**20.5**	**21**	**22.5**	**10**	**166**

Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

VERTICALS FOR MINOR DEGREE (in additions to all the verticals of other programmes)

Vertical I Fintech and Block Chain	Vertical II Entrepreneurship	Vertical III Public Administration	Vertical IV Business Data Analytics	Vertical V Environment and Sustainability
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL I: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL II: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneruship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL III: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL IV: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL V: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

IP3151 **INDUCTION PROGRAMME**

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:

Guide to Induction program from AICTE

HS3152	**PROFESSIONAL ENGLISH I**	**L T P C**
		3 0 0 3

OBJECTIVES:

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 9

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9

Reading – Newspaper articles; Journal reports –and Non Verbal Communcation (tables, pie charts etc,.). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart , graph etc, to verbal mode)
Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION 9

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL : 45 PERIODS

LEARNING OUTCOMES:

At the end of the course, learners will be able

- To use appropriate words in a professional context
- To gain understanding of basic grammatical structures and use them in right context.
- To read and interpret information presented in tables, charts and other graphic forms
- To write definitions, descriptions, narrations and essays on various topics

TEXT BOOKS :

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.
   Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
AVg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3151 MATRICES AND CALCULUS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS 9+3

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+3

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 9+3

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to

- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems

TEXT BOOKS :

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., " Calculus " Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, " Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14th Edition, Pearson India, 2018.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

PH3151 **ENGINEERING PHYSICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS **9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

UNIT II ELECTROMAGNETIC WAVES **9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS **9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser –Basic applications of lasers in industry.

UNIT IV BASIC QUANTUM MECHANICS **9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS **9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

TOTAL : 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students should be able to

- Understand the importance of mechanics.
- Express their knowledge in electromagnetic waves.
- Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- Understand the importance of quantum physics.
- Comprehend and apply quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

REFERENCES:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
AVG	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

1-Low,2-Medium,3-High,"-"-no correlation

Note: the average value of this course to be used for program articulation matrix.

CY3151 ENGINEERING CHEMISTRY

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I WATER AND ITS TREATMENT 9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II NANOCHEMISTRY 9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES 9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two

component system: lead-silver system - Pattinson process.
Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.
Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO_2 emission and carbon foot print.

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles; working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course, the students will be able:
- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, “A Text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, “Text book of nanoscience and nanotechnology”, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
Avg.	2.8	1.3	1.6	1	-	1.5	1.8	-		-	-	1.5	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation

GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNI\T III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and looping for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

COs- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
AVg.	**2**	**3**	**3**	**3**	**2**	-	-	-	-	-	**2**	**2**	**3**	**3**	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

GE3152 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I <u>**மொழி மற்றும் இலக்கியம்**</u> **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **<u>நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்</u>**: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **<u>தமிழர்களின் திணைக் கோட்பாடுகள்</u>**: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **<u>இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</u>**: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3152 HERITAGE OF TAMILS L T P C
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY **L T P C**
0 0 4 2

OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here**.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter’s age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, students will be able to:
CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems..
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

1. Allen B. Downey, “Think Python : How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.

3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‟, Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

COs- PO's & PSO's MAPPING

CO's	PO's													PSO's	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3	-
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-	-
AVg.	**2**	**3**	**3**	**3**	**2**	-	-	-	-	-	**2**	**2**	**3**	**3**	-

1 - low, 2 - medium, 3 - high, '-' - no correlation

BS3171 PHYSICS AND CHEMISTRY LABORATORY **L T P C**

PHYSICS LABORATORY: (Any Seven Experiments) **0 0 4 2**

COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

OUTCOMES:

Upon completion of the course, the students should be able to

- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.

- Solve problems individually and collaboratively.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
AVG	3	2.4	2.6	1	1										

- **1-Low,2-Medium,3-High,"-"-no correlation**
- **Note: the average value of this course to be used for program articulation matrix.**

CHEMISTRY LABORATORY: (Any seven experiments)

OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

1. Preparation of Na_2CO_3 as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL: 30 PERIODS

OUT COMES :

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles
- To quantitatively analyse the impurities in solution by electroanalytical techniques

TEXT BOOK:

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg.	**2.6**	**1.3**	**1.6**	**1**	**1**	**1.4**	**1.8**	**-**	**-**	**-**	**-**	**1.3**	**-**	**-**	**-**

- **1-low, 2-medium, 3-high, '-"- no correlation**

GE3172 ENGLISH LABORATORY L T P C
0 0 2 1

OBJECTIVES :

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions(filling out a bank application for example).

UNIT II NARRATION AND SUMMATION 6

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

UNIT V EXPRESSION 6

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions- understanding a website-describing processes

TOTAL : 30 PERIODS

LEARNING OUTCOMES:

At the end of the course, learners will be able

- To listen to and comprehend general as well as complex academic ~~texts~~ information

- To listen to and understand different points of view in a discussion
- To speak fluently and accurately in formal and informal communicative contexts
- To describe products and processes and explain their uses and purposes clearly and accurately
- To express their opinions effectively in both formal and informal discussions

ASSESSMENT PATTERN

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
AVg.	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

HS3252 PROFESSIONAL ENGLISH -II **L T P C**
2 0 0 2

OBJECTIVES :

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

UNIT I MAKING COMPARISONS 6

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING 6

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH 6

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, learners will be able

- To compare and contrast products and ideas in technical texts.
- To identify and report cause and effects in events, industrial processes through technical texts
- To analyse problems in order to arrive at feasible solutions and communicate them in the written format.
- To present their ideas and opinions in a planned and logical manner
- To draft effective resumes in the context of job search.

TEXT BOOKS :

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
AVg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3251 STATISTICS AND NUMERICAL METHODS

	L	T	P	C
	3	1	0	4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9+3

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students will be able to:

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10^{th} Edition, New Delhi, 2015.

2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

CO-PO & PSO MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

1-Low,2-Medium,3-High,"-"-no correlation

Note: the average value of this course to be used for program articulation matrix.

PH3258 PHYSICS OF MATERIALS

L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand the basics of phase diagrams and various materials preparation techniques
- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about superconductors
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To familiarize the students with the theory and applications of magnetic and dielectric materials
- To provide the students a sound platform towards learning about advanced materials and their applications.

UNIT I PREPARATION OF MATERIALS 9

Phases - phase rule – binary systems – tie line – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

UNIT II ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law - Quantum free electron theory – tunneling - degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING PROPERTIESMATERIALS 9

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Ceramics – types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape memory alloys – Copper, Nickel and Titanium based alloys – grapheme and its properties – Relaxor ferroelectrics - Biomaterials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – Polymer semiconductors – Photoconducting polymers.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students should be able to

- acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
- familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.
- gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.
- realize with theories and applications of dielectric and ferromagnetic materials
- familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

TEXT BOOKS:

1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. V.Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.

REFERENCES:

1. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
2. D.R. Askeland and W.J.Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Jean P.Mercier, G.Zambelli and W.Kurz, Introduction to Materials Science, Elsevier, 2002.
5. Yaser Dahman, Nanotechnology and Functional Materials for Engineers, Elsevier, 2017.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	3	2	1	2	1	-	-	-	1	-	-	-
2	3	3	2	-	-	1	-	-	-	-	-	-	-	-	-
3	3	2	2	1	-	2	1	-	-	-	-	1	-	-	-
4	3	2	-	1	2	2	2	-	-	-	-	1	-	-	-
5	3	-	2	-	2	2	2	-	-	-	-	1	-	-	-
AVG	3	2.25	2	1.66	2	1.6	1.75	1				1			

1-Low,2-Medium,3-High,"-"-no correlation

Note: the average value of this course to be used for program articulation matrix.

BE3252 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING **L T P C 3 0 0 3**

OBJECTIVES:

- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

UNIT I ELECTRICAL CIRCUITS 9

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

UNIT II MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS 9

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit- Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

UNIT III ELECTRICAL MACHINES 9

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

UNIT IV ANALOG ELECTRONICS 9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

UNIT V SENSORS AND TRANSDUCERS 9

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors,Strain gauge, LVDT, differential pressure transducer,optical and digital transducers, Smart sensors, Thermal Imagers.

TOTAL: 45 PERIODS

OUTCOMES :

After completing this course, the students will be able to

CO1: Compute the electric circuit parameters for simple problems
CO2: Explain the concepts of domestics wiring and protective devices
CO3: Explain the working principle and applications of electrical machines
CO4: Analyze the characteristics of analog electronic devices
CO5: Explain the types and operating principles of sensors and transducers

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits,Wiley,2018

REFERENCES:

1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition.,Cengage India, 2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

CO's, PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1					1					-	-	-
2	2	1	1					1					-	-	-
3	2	1	1					1					-	-	-
4	2	1	1					1					-	-	-
5	2	1	1					1					-	-	-
Avg.	2	1	1					1					-	-	-

1-Low,2-Medium,3-High,"-"-no correlation

Note: the average value of this course to be used for program articulation matrix.

GE3251 ENGINEERING GRAPHICS L T P C
2 0 4 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

i. Drawing engineering curves.
ii. Drawing freehand sketch of simple objects.
iii. Drawing orthographic projection of solids and section of solids.
iv. Drawing development of solids
v. Drawing isometric and perspective projections of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

UNIT I PLANE CURVES 6+12

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING 6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.
Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.
Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

TOTAL: (L=30+P=60) 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

TEXT BOOKS:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

CO's, PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2		2					3		2	2	2	
2	3	1	2		2					3		2	2	2	
3	3	1	2		2					3		2	2	2	
4	3	1	2		2					3		2	2	2	
5	3	1	2		2					3		2	2	2	
Avg	**3**	**1**	**2**		**2**					**3**		**2**	**2**	**2**	
Low (1) ; Medium (2) ; High (3)															

1-Low,2-Medium,3-High,"-"-no correlation

CH3251 INTRODUCTION TO CHEMICAL ENGINEERING **L T P C**
3 0 0 3

OBJECTIVES:

To acquaint the students with the fundamentals of Chemical Engineering and to build their perspective in a wholesome manner

UNIT I INTRODUCTION 9

Chemical Engineering in day to life with examples, Origin and growth of chemical Engineers in chemical process industries, unit operations and unit processes concepts, scaling up or down, units and dimensions, application of mathematics in chemical Engg, recent developments in chemical process industries

UNIT II INTRODUCTION TO MATERIAL AND ENERGY BALANCES 9

Basic concepts of material and energy balances, energy and mass transport, and kinetics of chemical reactions. Introduction to heat and mass transfer. Process flow sheeting and symbols.

UNIT III FLUID FLOW 9

Nature of fluid, Viscosity, Flow field, Conservation of mass and energy. Frictional losses, pumping of fluids. Dimensional Analysis and Correlations.

UNIT IV CHEMICAL ENGINEERING COMPUTER SOFTWARE TOOLS AND APPLICATIONS 9

Introduction to Process Engineering Design Software (HYSYS and PRO II) , Computations Using Microsoft Excel, Computer-Aided Design & Drafting, Piping and Equipment Design Software

UNIT V CAREER DIVERSITIES IN CHEMICAL ENGINEERING 9

Career Development Leading to Specialization, Chemical Engineering Job Titles/Options, Chemical and Process Engineers, Commissioning Engineer, Process Control/Automation Engineer, Process Safety Engineer, Research & Development Engineer Pharmaceutical Engineer/Pharmaceutical Process Engineer, Pipeline Engineer Chemical Manufacturing Engineer, Environment Engineer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, student should be able to:

CO1. Correlate day to day like with the principles of chemical Engineering.

CO2. Assess the mass and energy involved in any chemical plant.

CO3. Have an insight into areas where Chemical Engineering plays major role.

CO4. Carry out modelling and simulation using software tools.

CO5. Identify their right future.

CO6: Gain confidence and outline about the programme as a whole.

TEXT BOOKS:

1. Anderson, L.B., Wenzel, L.A., “Introduction to Chemical Engineering", McGraw-Hill Book Company, Inc., New York (1961).
2. Pushpavanam, S., "Introduction to Chemical Engineering", PHI Learning Pvt. Ltd.(2012).
3. Ghosal, S.K., Sanyal, S.K., Datta, S., “Introduction to Chemical Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi(1997).

REFERENCES:

1. Rao, M.G., Sittig, M., “Dryden’s Outlines of Chemical Technology”, East-West Press (1997).
2. Perry, R.H., Green, D.W., “Perry's Chemical Engineers' Handbook”, McGraw-Hill Book Company (2008).

Course articulation matrix

Course Outcomes	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Correlate day to day like with the principles of chemical Engineering	3	2	3	1	-	-	-	-	-	-	-	1	2	-	-
CO2	Assess the mass and energy involved in any chemical plant.	3	2	3	1	-	-	-	-	-	-	-	1	2	2	-
CO3	Have an insight into areas where Chemical Engineering plays major role.	3	2	3	1	-	-	-	-	-	-	1	-	2	2	-
CO4	Carry out modelling and simulation using software tools	3	2	3	1	1	1	1	1	-	-	1	1	2	2	-
CO5	Identify their right future															
CO6	Gain confidence and outline about the programme as a whole	3	2	3	-	-	-	-	-	-	-	-	1	2	2	-
OverallCO		3	2	3	1	1	1	1	1	-	-	1	1	2	2	-

1,2and3 are correlationlevelswith weightingsasSlight (Low), Moderate(Medium)andSubstantial (High)respectively

GE3252 **<u>தமிழரும் தொழில்நுட்பமும்</u>** **L T P C**
1 0 0 1

அலகு I **<u>நெசவு மற்றும் பானைத் தொழில்நுட்பம்</u>**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **<u>வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்</u>**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **<u>உற்பத்தித் தொழில் நுட்பம்</u>**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **<u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **<u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3252 TAMILS AND TECHNOLOGY L T P C
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

NX3251	**(ARMY WING) NCC Credit Course Level - I**	**L T P C**
		2 0 0 2
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

NX3252	**(NAVAL WING) NCC Credit Course Level - I**	**L T P C**
		2 0 0 2
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

		L	T	P	C
NX3253	**(AIR FORCE WING) NCC Credit Course Level - I**	**2**	**0**	**0**	**2**

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

GE3271 ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in commonhousehold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers,elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

WOOD WORK:

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an airconditioner.

SHEET METAL WORK:

a) Making of a square tray

FOUNDRY WORK:

a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

a) Study an elements of smart phone..
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop

TOTAL : 60 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to:

- Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
- Wire various electrical joints in common household electrical wire work.
- Weld various joints in steel plates using arc welding work; Machine various simple processeslike turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
- Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO's, PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2			1	1	1					2	2	1	1
2	3	2			1	1	1					2	2	1	1
3	3	2			1	1	1					2	2	1	1
Avg	**3**	**2**			**1**	**1**	**1**					**2**	**2**	**1**	**1**
Low (1) ; Medium (2) ; High (3)															

1-Low,2-Medium,3-High,"-"-no correlation

BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY

L T P C
0 0 4 2

OBJECTIVES:

- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

LIST OF EXPERIMENTS

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

OUTCOMES:

After completing this course, the students will be able to

CO1: Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power

CO2: Analyze experimentally the load characteristics of electrical machines

CO3: Analyze the characteristics of basic electronic devices

CO4: Use LVDT to measure displacement

CO's, PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	1	2				1.5	2				-	-	-
2	2	3	1	2				1.5	2				-	-	-
3	2	3	1	2				1.5	2				-	-	-
4	2	3	1	2				1.5	2				-	-	-
Avg.	1.6	1.4	0.8	1.6				1.2	1.6						

1-Low,2-Medium,3-High,"-"-no correlation

GE3272 COMMUNICATION LABORATORY

L T P C
0 0 4 2

OBJECTIVES

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

UNIT I 12

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life- discussing past events-Writing: writing emails (formal & semi-formal).

UNIT II 12

Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

UNIT III **12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

UNIT IV **12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-(example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

UNIT V **12**

Speaking: describing things relatively-describing clothing-discussing safety issues(making recommendations) talking about electrical devices-describing controlling actions- Writing:
job application(Cover letter + Curriculum vitae)-writing recommendations.

TOTAL: 60 PERIODS

LEARNING OUTCOMES

At the end of the course, learners will be able

- Speak effectively in group discussions held in a formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

Assessment Pattern

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

- 1-low, 2-medium, 3-high, ‘-“- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

MA3356 **DIFFERENTIAL EQUATIONS** **L T P C**
3 1 0 4

OBJECTIVES :

- To acquaint the students with Differential Equations which are significantly used in engineering problems
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.
- To understand the finite methods for time dependent partial differential equations.
-

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Higher order linear differential equations with constant coefficients – Particular integrals: Operator methods, Method of variation of parameters, Methods of undetermined coefficients– Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients .

UNIT II PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Explicit Adams-Bashforth Techniques, Implicit Adams-Moulton Techniques, Predictor-Corrector Techniques, Finite difference methods for solving two-point linear boundary value problems, Orthogonal Collocation method.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9+3

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes.

UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 9+3

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – First order hyperbolic equations – method of characteristics, different explicit and implicit methods; Wave equation: Explicit scheme- Stability of above schemes.

TOTAL : 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students will be able to:

- Apply various methods of solving differential equation which arise in many application problems.
- Understand how to solve the given standard partial differential equations.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
- Familiar with various methods to solve time dependent partial differential equations.

TEXT BOOKS:

1. Grewal. B.S, "Higher Engineering Mathematics", 44 th Edition, Khanna Publications, New Delhi, 2018.
2. Gupta S.K., "Numerical Methods for Engineers" (Third Edition), New Age Publishers, New Delhi , 2015.
3. M K Jain , S R K Iyengar , R K Jain, "Computational Methods for Partial Differential Equations", New Age Publishers, New Delhi , , 1994.

REFERENCES :

1. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
2. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
3. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
4. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009. Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

CO's, PO's & PSO's MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	0	0	0	0	1	2	2	1	2
CO2	3	3	2	2	1	1	2	0	2	1	2	0	3	1	1
CO3	3	3	3	2	2	1	0	0	0	0	0	2	1	2	1
CO4	3	3	2	1	2	1	0	0	0	0	0	2	2	1	0
CO5	3	3	2	1	1	1	0	0	0	0	0	2	2	1	1
Avg.	3	3	2.4	1.8	1.6	1	0.4	0	0.4	0.2	0.6	1.6	2	1.2	1

1-Low,2-Medium,3-High,”-“-no correlation

CH3301 BASIC MECHANICAL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I LAWS OF THERMODYNAMICS 9

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES 9

Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III AIR STANDARD CYCLES 9

Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND TEAM 9

Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.
Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle. Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALNCING 9

Definition of Kinematic Links, Pairs and Kinematic Chains; Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On Completion of the course, the students would

- Understand the basic concepts and Laws of thermodynamics and its applications.
- Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries
- Understand the various thermodynamic cycles with its derivation
- Understand the thermal engineering equipments like IC engine etc with its performance, and rankine cycle
- Understand the drives used to transmit power from one shaft to another belt drive, chain drive, gear drive etc and flywheel.

TEXT BOOKS

1. Nag, P.K., “Engineering Thermodynamics “, IInd Edition, Tata McGraw Hill Publishing Co., Ltd., 1995
2. Rajput, R .K, “Thermal Engineering”, Laxmi publications (P) Ltd, 2001.
3. Khurmi R.S., and Gupta J.K, “Theory of Machines”, Eurasia Publishing House (P) Ltd., 2004.

REFERENCES

1. Bhaskaran, K.A., and Venkatesh, A., “Engineering Thermodynamics “,Tata McGraw Hill, 1973.
2. Khurmi R.S., and Gupta J.K, “Thermal Engineering”, S.Chand & Company (P) Ltd.,2001.
3. Kothandaraman and Dhomkundwar,”: A course in Thermal Engineering (SI Units)”, Dhanpat

Rai and Sons, Delhi (2001)

4. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
5. Smith, "Chemical Thermodynamics ", Reinhold Publishing Co., 1977.

Course articulation matrix

Course Outcomes	Program Outcomes															
	Statements	**PO 1**	**PO2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PSO 3**
CO1	Understand the basic concepts and Laws of thermodynamics and its applications	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**-**
CO2	Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO3	Understand the various thermodynamic cycles with its derivation	**2**	**2**	**2**	**-**	**-**	**2**	**-**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**2**
CO4	Understand the thermal engineering equipments like IC engine etc with its performance, and rankine cycle	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**2**	**-**	**2**
CO5	Understand the drives used to transmit power from one shaft to another belt drive, chain drive, gear drive etc and flywheel.	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
OVERALL CO		**3**	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3302 **MECHANICS OF SOLIDS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on designing the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing.

UNIT I STRESS, STRAINAND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – forces on solids and supports – equilibrium and stability – strength and stiffness – tension, compression and shear stresses – Hooke's law and simple problems – compound bars – thermal stresses – elastic constants and poission's ratio.

UNIT II TRANSVERSE LOADING ON BEAMS 9

Beams –support conditions–types of Beams –transverse loading on beams–shear force and bending moment in beams–analysis of can tilevers, simply – supported beams and over hanging beams – relationships between loading, S.F. and B.M.Inbeams and their applications– S.F.& B.M. diagrams.

UNIT III DEFLECTIONS OF BEAMS 9

Double integration method – Macaulay's method –Area – moment theorems for computation of slopes and deflections in beams.

UNIT IV STRESSES IN BEAMS 9

Theory of simple bending – assumptions and derivation of bending equation (M/I=F/Y= E/R)– analysisofstressesinbeams–loadscarryingcapacityofbeams–proportioningbeam sections – leaf springs – flitched beams – shear stress distribution in beams – determination of shear stress in flanged beams.

UNIT V TORSIONAND COLUMNS 9

Torsion of circular shafts – derivation of torsion equation (T/J = fs/R = Cθ/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts– stepped shafts – shafts fixed at both ends– stresses inhelical springs–deflection of springs–spring constant. Axially loaded short columns–columns of unsymmetrical sections– Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Upon completion of the course, the students would be able to
- Understand the basic concepts of stress, strain and deformation of solids
- Understand the concept of transverse loading on statistically deterministic beams and its
- Understand the concept of slope and deflection in beams through Double Integration,
- Understand the stress distribution concept like bending and shear stresses in beams and leaf springs
- Understand the stress and deformation in shafts, analysis of columns by Euler's theory and effect of eccentricity.

TEXT BOOKS:

1. Junarkar, S. B., Mechanics of Structure Vol.1, 21st Edition, Character Publishing House, Anand, Indian, (1995).
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series.
3. McGraw Hill International Editions, Third Edition, 1994.
4. Bansal, R.K, Strength of Materials, Laxmi Publications(P) Ltd., Fourth Edition 2010

REFERENCE:

1. Elangovan A. ,Thinma VisaiIyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

Course articulation matrix

Course Outcomes	Program Outcomes															
	Statements	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO 3**
CO1	Understand the basic concepts of stress, strain and deformation of solids	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**2**	**-**
CO2	Understand the concept of transverse loading on statistically deterministic beams and its	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO3	Understand the concept of slope and deflection in beams through Double Integration,	**2**	**2**	**2**	**-**	**-**	**2**	**-**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**2**
CO4	Understand the stress distribution concept like bending and shear stresses in beams and leaf springs	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**2**	**-**	**2**
CO5	Understand the stress and deformation in shafts, analysis of columns by Euler's theory and effect of eccentricity.	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
OVERALL CO		**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3351 CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the students to acquire knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I 9

Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II 9

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT III 9

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV 9

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction -Energy balance for systems with and without chemical reaction - Unsteady state energy balances

UNIT V 9

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students would be able to

- Understand the concepts of dimensional consistency and effective application of units and dimensions.
- Analyze a problem statement and balance the material flowing through single and various operations
- Understand the gas behavior and its properties
- Understand general energy balance, simplify and apply to open and closed systems
- Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes

TEXT BOOKS:

1. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Eighth Edition, Prentice Hall Inc., 2012
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",5 th Edn., John Wiley & Sons, New York, 2005.

REFERENCE:

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers ,Second edition,2004.

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the concepts of dimensional consistency and effective application of units and dimensions.	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO2	Analyze a problem statement and balance the material flowing through single and various operations	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO3	Understand the gas behavior and its properties	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO4	Understand general energy balance, simplify and apply to open and closed systems	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
OVERALL CO		2	3	2	3	3	2	1	1	1	1	1	1	2	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3352 FLUID MECHANICS FOR CHEMICAL ENGINEERS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the students to acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

UNIT I 9

Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II 9

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.

UNIT III 9

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV 9

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V 9

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

TOTAL: 45 PERIODS

OUTCOME OUTCOMES:

On completion of the course, the students would be able to

- Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.
- Apply Bernouli principle, Navier - Stokes equation and compute pressure variation in static fluid.
- Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.
- Understand the different types of flow conditions in fixed bed and fluidized beds.
- Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Third Edition, McGraw-Hill, (2017).
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2017
3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 9th Edition", John Wiley, 2021

REFERENCES:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)

Course articulation matrix:

	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	Program Outcomes															
CO1	Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.	3	3	-	-	-	-	-	-	-	1	2	-	3	1	-
CO2	Apply Bernouli principle, Navier - Stokes equation and compute pressure variation in static fluid.	-	3	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.	-	3	3	3	2	-	2	-	-	3	1	2	-	-	2
CO4	Understand the different types of flow conditions in fixed bed and fluidized beds.	3	-	3	3	2	-	2	-	-	-	-	3	3	-	-
CO5	Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.	2	3	-	3	-	2	1	1	-	-	-	-	-	2	2
OVERALL CO		3	3	3	3	3	3	2	3	2	1	1	2	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3303 **CHEMICAL PROCESS INDUSTRIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY 9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries, Phosphoric acid, Single Super Phosphate, DAP, MAP and NPK – Potassium chloride, Potassium Sulphate – Liquid Fertilizers – Bio Fertilizers.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V FUEL AND INDUSTRIAL GASES 9

Fuel Gases – Natural gas, Liquefied natural gas, Synthesis Gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen – Argon.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1 : Understand the various unit operations and processes with their symbols
CO2 : Understand the various chemical reactions involved in the process
CO3 : Students will know to draw the process Flow sheet and understand the major engineering problems encountered in the processes.
CO4 : To learn manufacturing processes of organic and Inorganic Chemicals and its applications.
CO5 : Students will understand the role of chemical Engineering in the process plants

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley,Second edition 2013.

REFERENCE:

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th ed., McGraw-Hill, 2017.
2. Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd

Course Articulation Matrix:

Course Outcomes	Program Outcomes															
	Statements	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	Understand the various unit operations and processes with their symbols	3	2	3	2	1	1	-	-	-	-	-	1	2	3	2
CO2	Understand the various chemical reactions involved in the process	2	2	3	3	2	1	-	1	1	1	1	-	2	2	2
CO3	Students will know to draw the process Flow sheet and understand the major engineering problems encountered in the processes.	3	2	2	2	2	1	-	1	1	1	-	1	1	1	1
CO4	To learn manufacturing processes of organic and Inorganic Chemicals and its applications.	2	3	3	2	3	1	1	-	-	-	-	2	2	2	2
CO5	Students will understand the role of chemical Engineering in the process plants	2	3	3	2	3	1	1	-	1	-	1	1	2	2	3
OVERALL CO		2	2	3	2	2	1	1	1	1	1	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3311 BASIC MECHANICALENGINEERING LABORATORY

L T P C
0 0 3 1.5

COURSE OBJECTIVES:

The course is aimed to

- Impart practical knowledge in operating IC engines and conduct experiments.
- To make the students understand the test procedures in testing material for engineering applications

LIST OF EXPERIMENTS*

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.

CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.

CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.

CO4: Evaluate the heat distribution from engine and preparing heat balancechart.

CO5: Estimate the engine performance with mechanical loading

CO6: Estimate the PTD and VTD of two and four stroke engines

Course Articulation Matrix:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Determine Brake power,Indicated power and frictionalpower of single cylinder diesel engines.	3	3	3	2	2	2	3	2	3	2	2	3	3	2	-
CO2	Determine Brake power,Indicated power and frictionalpower of twin cylinder diesel engines.	2	2	3	2	2	2	2	3	3	2	3	3	3	2	2
CO3	Determine Brake power,Indicated power and frictionalpower of single cylinder petrol engines.	2	2	2	-	-	2	-	2	3	2	2	3	2	2	2
CO4	Evaluate the heat distributionfrom engine and preparing heat balance chart.	3	3	3	2	-	-	-	-	2	2	2	2	2	-	2
CO5	Estimate the engine performance with mechanical loading	3	3	3	2	3	3	2	3	2	2	3	3	2	2	2
OVERALL CO		3	3	3	3	2	2	2	3	2	3	2	2	3	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3312 **TECHNICAL ANALYSIS LABORATORY** **L T P C**
0 0 3 1.5

COURSE OBJECTIVES:

- To learn basic principles involved in estimation and characterization of industrially important materials.

Experiments:

I. Soap Analysis
a. Estimation of total fatty acid
b. Estimation of percentage alkali content
II. Oil Analysis
a. Estimation of free acid
b. Determination of Saponification value
c. Determination of iodine value
III. Cement Analysis
a. Estimation of Silica content
b. Estimation of mixed oxide content
c. Estimation of calcium oxide content
d. Estimation of calcium oxide by rapid method
IV. Coal Analysis
a. Estimation of Sulphur present in coal
b. Ultimate analysis of coal
c. Proximate analysis of coal
V. Analysis of Bleaching Powder
a. Estimation of available chlorine
VI. Analysis of Glycerol
Estimation of purity of glycerol
VII. Analysis of fuels
a. Flash point
b. Fire point
c. Cloud point
d. Pour point
e. Aniline point.

COURSE OUTCOMES:

Course Outcomes	Program Outcomes															
	Statements	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the estimation and analysis of Soap.	1	3	3	2	2	2	3	2	3	2	2	3	3	2	-
CO2	Understand the estimation and analysis of Cement Analysis	1	2	3	2	2	2	2	3	3	2	3	3	3	2	1
CO3	Understand the estimation and analysis of Coal Analysis	1	2	2	-	-	2	-	2	3	2	2	3	2	2	1
CO4	Understand the estimation and analysis of Analysis of Glycerol	1	3	3	2	-	-	-	-	2	2	2	2	2	-	1
CO5	Understand the estimation and analysis of Analysis of fuels	1	3	3	2	3	3	2	3	2	2	3	3	2	1	2
OVERALL CO		1	3	3	3	2	2	2	3	2	3	2	2	3	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

GE3361 PROFESSIONAL DEVELOPMENT **L T P C**
0 0 2 1

OBJECTIVES:

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize,interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

MS WORD: **10 Hours**

Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations
Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

MS EXCEL: **10 Hours**

Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions
Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

MS POWERPOINT: **10 Hours**

Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master
Working with animation and transitions
Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

TOTAL: 30 PERIODS

OUTCOMES:

On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

- Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
- Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

MA3451 TRANSFORM TECHNIQUES L T P C
3 1 0 4

OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I VECTOR CALCULUS 9+3
Gradient and directional derivative – Divergence and curl - Irrotational and solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and applications in evaluating line, surface and volume integrals.

UNIT II FOURIER SERIES 9+3
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value - Parseval's identity – Harmonic analysis.

UNIT III FOURIER TRANSFORMS 9+3
Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT IV LAPLACE TRANSFORMS 9+3
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3
Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL: 60 PERIODS

OUTCOMES
Upon successful completion of the course, students should be able to:

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Understand the mathematical principles on Laplace transforms and would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS

1. Grewal B.S., “Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

COURSE OUTCOMES:

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	0	0	0	0	2	1	2	2	1
CO2	3	3	2	2	1	2	1	0	1	0	2	0	3	2	1
CO3	3	2	1	2	1	0	1	1	0	0	3	0	2	2	2
CO4	3	3	3	1	0	0	0	0	0	0	1	0	1	2	1
CO5	3	3	2	2	1	0	1	0	2	1	2	0	3	1	2
Overall CO	3	2.8	2.2	1.6	0.8	0.6	0.8	0.2	0.6	0.2	2	0.2	2.2	1.8	1.4

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3451 **MASS TRANSFER I** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The course is aimed to enable the students

- Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I MOLECULAR DIFFUSION 9

Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion.

UNIT II CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER 9

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III HUMIDIFICATION OPERATIONS 9

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV DRYING 9

Drying – Equilibrium. Classification of dryers, batch drying – Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying, microwave drying

UNIT V CRYSTALLIZATION 9

Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the fundamentals, types and mechanism of mass transfer operations
CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer
CO3: Understand the basics of humidification process and its application
CO4: Understand the concept and mechanism of drying operations
CO5: Understand the concept of crystallization process and identification of suitable crystallizer And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations..

TEXT BOOKS:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill,2017.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., NewJersey, 2003.
3. Narayanan K.V. and Lakshmikutty, B "Mass Transfer – Theory and Applications", 1st Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2014.

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 5th Edition, Asian Books Pvt. Ltd., India, 2002.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 4th Ed., John Wiley, 2016

Course articulation matrix:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the fundamentals, types and mechanism of mass transfer operations	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO2	Understand the theories of mass transfer and the concept of interphase mass transfer	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO3	Understand the basics of humidification process and its application	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
CO4	Understand the concept and mechanism of drying operations	**3**	**3**	**3**	**-**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
CO5	Understand the concept of crystallization process and identification of suitable crystallizer And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations.	**3**	**3**	**3**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
OVERALL CO		3	**3**	**3**	**-**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**2**	**1**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PC3352 **MECHANICAL OPERATIONS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impact knowledge in the field of particle size reduction and also construction and working of equipment's used for mechanical operations.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT 9

General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT 9

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top-down approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, palletization, and flocculation. Fundamentals of particle generation.

UNIT III PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM) 9

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV FILTRATION AND FILTRATION EQUIPMENTS 9

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V MIXING AND PARTICLE HANDLING 9

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOME:

On completion of the course, the students will be able to
CO1: Understand and determine various properties of particulates
CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement
CO3: Understand various separation and purification techniques employed in solid particles
CO4: Enhance their knowledge on Filtration Process
CO5: Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 1994.
4. Hiroaki Masuda , KoHigashitani and Hideto Yoshida, Powder Technology Handbook, 3rd Edition.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. II, 4th Edn., Asian Books Pvt. Ltd., India, 1998.
2. Christie J. Geankoplis, Transport processes and unit operations.
3. Sunggyu Lee, Kimberly H. Henthorn, Particle Technology and Applications.
4. Martin Rhodes, Introduction to Particle Technology, Second Edition.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand and determine various properties of particulates	3	3	3	3	1	1	1	-	3	3	3	2	3	3	1
CO2	Gain Preliminary understanding on Size Reduction and Size Enlargement	3	2	2	2	2	1	1	-	1	2	2	2	2	3	1
CO3	Understand various separation and purification techniques employed in solid particles	3	2	2	3	3	1	3	2	1	2	3	2	2	3	3
CO4	Enhance their knowledge on Filtration Process	2	2	2	1	1	1	2	1	1	1	1	1	2	2	1
CO5	Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications	2	2	3	2	1	2	3	1	1	1	2	2	1	1	3
OVERALL CO		3	3	3	3	2	2	3	1	2	2	3	3	3	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3401 CHEMICAL ENGINEERING THERMODYNAMICS - I **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The course is aimed to enable the students to

- Learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I **9**

Terminologies of thermodynamics, the variables and quantities of thermodynamics, characteristics of systems and processes, energy classifications, point and path functions, energy in transition work and heat. Zeroth law; temperature scales

UNIT II **9**

The first law of thermodynamics, statements of first law for the flow and non-flow processes. PVT behaviour of fluids; Mathematical representation of PVT behaviour; generalized compressibility factor correlation; generalized equations of state

UNIT III **9**

Joule's experiment, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV **9**

Thermodynamic properties – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.

UNIT V **9**

Thermodynamic aspects of compression, expansion processes and duct flow of compressible fluids, steam power plant.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the fundamental concepts of thermodynamics and its related functions
CO2: Relate PVT behaviour of fluids and understand the real gas behavior
CO3: Apply second law and analyse the feasibility of system/devices
CO4: Analyse the thermodynamic property relations and their application to fluid flow
CO5: Develop the significance of thermodynamic potentials and their use in the analysis of processes and formulate thermodynamic formulations and the working of compressors and expanders

TEXT BOOKS:

1. Smith J.M., VanNess,H.C., &Abbot M.C," Introduction to Chemical Engineering Thermodynamics",McGraw Hill VII Edition 2009
2. Kyle B.G.,"Chemical and Process Thermodynamics", Pearson International third Edition.
3. Rao Y.V.C.,"Chemical Engineering Thermodynamics"Universities Press, 2005
4. Koretsky.,Engineering and Chemical thermodynamics,Wiley,2011

REFERENCES:

1. Sandler,S.I.,"Chemical and Engineering Thermodynamics",IV Edition,Wiley,2006.
2. Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics"Prentice Hall of India Pvt.Ltd,2 nd edition,2013.
3. Kevin Douglas, Fundamentals of Chemical Engineering Thermodynamics, Timothy Anderson,2015

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the fundamental concepts of thermodynamics and its related functions	3	2	1	-	1	-	2	-	-	2	1	-	3	-	-
CO2	Relate PVT behaviour of fluids and understand the real gas behavior	3	2	-	2	1	-	-	-	1	1	-	1	-	-	-
CO3	Apply second law and analyse the feasibility of system/devices	3	3	3	2	-	2	2	1	3	2	1	1	3	2	2
CO4	Analyse the thermodynamic property relations and their application to fluid flow	2	2	2	2	2	1	1	2	3	1	2	2	2	3	2
CO5	Develop the significance of thermodynamic potentials and their use in the analysis of processes and formulate thermodynamic formulations and the working of compressors and expanders	2	2	1	-	-	1	1	2	1	1	2	-	-	2	1
OVERALL CO		3	3	3	2	2	2	2	2	2	3	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3491 **HEAT TRANSFER** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The course is aimed to

- Teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students

UNIT I **9**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer ; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement-effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction

UNIT II **11**

Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate.

UNIT III **9**

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers

UNIT IV **8**

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling

UNIT V **8**

Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring's rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state.

CO2: Understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows

CO3: Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers

CO4 : The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation

CO5: Students will understand radiative heat transfer including blackbody radiation and Kirchoff'slaw, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems

TEXT BOOKS:

1. Holman, J. P., 'Heat Transfer ', 10th Edn., McGraw Hill,2010.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
4. B.K. Dutta, Heat transfer principles and applications, PHI Learning PVT Ltd, 2016

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering",6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

COURSE ARTICULATION MATRIX

Course Outcomes	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state.	3	3	3	2	1	1	-	-	-	-	-	1	2	2	2
CO2	understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows	2	2	3	3	2	1	-	1	1	1	1	-	1	2	2
CO3	Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers	3	2	2	2	2	1	1	1	1	1	-	1	1	1	1
CO4	The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation	2	2	3	2	3	1	1	-	-	-	-	2	2	1	1
CO5	Students will understand radiative heat transfer including blackbody radiation and Kirchoff'slaw, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems	2	3	3	2	3	1	1	-	1	-	1	1	2	2	1
OVERALL CO		3	2	3	3	2	2	1	1	1	1	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

L	T	P	C
2	0	0	2

OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

OUTCOMES:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCE BOOKS :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
Avg.	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation

NCC Credit Course Level 2*

NX3451	**(ARMY WING) NCC Credit Course Level - II**	**L T P C**
		3 0 0 3

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3
LEADERSHIP		**7**
L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
DISASTER MANAGEMENT		**13**
DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1

ENVIRONMENTAL AWARENESS & CONSERVATION		**3**
EA 1	Environmental Awareness and Conservation	3
GENERAL AWARENESS		**4**
GA 1	General Knowledge	4
ARMED FORCES		**6**
AF 1	Armed Forces, Army, CAPF, Police	6
ADVENTURE		**1**
AD 1	Introduction to Adventure Activities	1
BORDER & COASTAL AREAS		**2**
BCA 1	History, Geography & Topography of Border/Coastal areas	2

TOTAL: 45 PERIODS

NCC Credit Course Level 2*

NX3452 (NAVAL WING) NCC Credit Course Level - II

L	T	P	C
3	0	0	3

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3
LEADERSHIP		**7**
L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
DISASTER MANAGEMENT		**13**
DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1
ENVIRONMENTAL AWARENESS & CONSERVATION		**3**
EA 1	Environmental Awareness and Conservation	3
GENERAL AWARENESS		**4**
GA 1	General Knowledge	4
NAVAL ORIENTATION		**6**
AF 1	Armed Forces and Navy Capsule	3
EEZ 1	EEZ Maritime Security and ICG	3
ADVENTURE		**1**
AD 1	Introduction to Adventure Activities	1
BORDER & COASTAL AREAS		**2**
BCA 1	History, Geography & Topography of Border/Coastal areas	2

TOTAL: 45 PERIODS

NCC Credit Course Level 2*

NX3453	(AIR FORCE WING) NCC Credit Course Level - II	L T P C 3 0 0 3

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Change your mindset, Time Management, Social Skills	6
PD 5	Public Speaking	3
LEADERSHIP		**7**
L 2	Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965	7
DISASTER MANAGEMENT		**13**
DM 1	Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation	3
DM 2	Initiative Training, Organising Skills, Do's & Don’t's, Natural Disasters, Man Made Disasters	9
DM 3	Fire Service & Fire Fighting	1
ENVIRONMENTAL AWARENESS & CONSERVATION		**3**
EA 1	Environmental Awareness and Conservation	3
GENERAL AWARENESS		**4**
GA 1	General Knowledge	4
GENERAL SERVICE KNOWLEDGE		**6**
GSK 1	Armed Forces & IAF Capsule	2
GSK 2	Modes of Entry in IAF, Civil Aviation	2
GSK 3	Aircrafts - Types, Capabilities & Role	2
ADVENTURE		**1**
AD 1	Introduction to Adventure Activities	1
BORDER & COASTAL AREAS		**2**
BCA 1	History, Geography & Topography of Border/Coastal areas	2

TOTAL: 45 PERIODS

CH3411	FLUID MECHANICS LABORATORY	L T P C 0 0 3 1.5

COURSE OBJECTIVES:

- To enable the students to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS

1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

***Minimum 10 experiments shall be offered**

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students would be able to

CO1 Identify and characterize of flow patterns and regimes

CO2 Calibrate flow measurement devices

CO3 Correlate the difference between fixed and fluidized bed columns and its application.

CO4 Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties

CO5 Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions

Course Articulation Matrix:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Identify and characterize of flow patterns and regimes	3	3	-	-	-	-	-	-	-	-	-	2	3	3	-
CO2	Calibrate flow measurement devices	-	3	3	3	-	-	-	-	-	-	-	2	3	3	-
CO3	Correlate the difference between fixed and fluidized bed columns and its application.	-	3	3	3	-	-	-	-	-	-	-	2	3	3	3
CO4	Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties	3	3	3	-	2	-	-	-	-	-	-	2	3	3	3
CO5	Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions	3	3	3	3	2	-	2	-	-	3	2	3	3	3	3
OVERALL CO		3	3	3	3	2	2	2	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3412 MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

The course is aimed to

- Develop sound practical knowledge on different types of mechanical operations equipments.

LIST OF EXPERIMENTS*

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the size analysis in solid- solid separation systems

CO2: Capability to select different solid - fluid separation equipments.

CO3: Evaluate the size reduction and various crushing parameters

CO4: Estimate the separation characteristics

CO5: Understand the technical methods related to unit operations in process plant

Course Articulation Matrix:

Course Outcomes	**Program Outcomes**															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Determine the size analysis in solid- solid separation systems	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**1**	**3**	**2**	**1**	**2**	**3**	**2**	**1**
CO2	Capability to select different solid - fluid separation equipments.	**3**	**3**	**2**	**3**	**1**	**2**	**3**	**2**	**2**	**1**	**2**	**1**	**3**	**3**	**2**
CO3	Evaluate the size reduction and various crushing parameters	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**3**	**2**	**1**
CO4	Estimate the separation characteristics	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**1**
CO5	Understand the technical methods related to unit operations in process plant	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**
OVERALL CO		**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3513 INDUSTRIAL TRAINING / INTERNSHIP I* L T P C
0 0 0 1

OBJECTIVES:

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of. Weeks: 02

OUTCOMES:

On completion of the course, the student will know about

CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial / research problems and their solutions

CO3: Documenting of material specifications, machine and process parameters, testing parameters and results

CO4: Preparing of Technical report and presentation

CH3501 CHEMICAL ENGINEERING THERMODYNAMICS II L T P C
3 0 0 3

OBJECTIVE:

The course is aimed to

- Understand the phase Behavior of fluids under different PVT conditions and apply them for practical purposes. The course will render a comprehensive understanding of theory and application of solution thermodynamics.

UNIT I SOLUTION THERMODYNAMICS 6

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures, pure species and liquids.

UNIT II PHASE EQUILIBRIA 12

Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 12

Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

UNIT V REFRIGERATION 6

Principles of refrigeration, methods of producing refrigeration, liquefaction process, coefficient of performance, Evaluation and performance of vapor compression and gas refrigeration cycles.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the systematic development of new class of properties to describe real mixtures

CO2: Develop the idea of chemical potential to derive the idea of phase equilibria

CO3: Understand the relationship connecting T, P and composition originating from the concept of chemical potential and fugacity coefficient

CO4: Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.

CO5: Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of Liquefaction processes

TEXT BOOKS:

1. Smith J.M., Van Ness, H.C., &Abbot M.C," Introduction to Chemical Engineering thermodynamics", McGraw Hill VII Edition 2009
2. Kyle B.G.," Chemical and Process Thermodynamics", Pearson International third Edition 2015.
3. Rao Y.V.C.," Chemical Engineering Thermodynamics" Universities Press,2005

REFERENCES

1. Sandler,S.I.,"Chemical and Engineering Thermodynamics",IV Edition,Wiley,2006.
2. Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics "Prentice Hall of India Pvt.Ltd,2nd edition,2013

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the systematic development of new class of properties to describe real mixtures	3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO2	Develop the idea of chemical potential to derive the idea of phase equilibria	3	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO3	Understand the relationship connecting T, P and composition originating from the concept of chemical potential and fugacity coefficient	3	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO4	Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.	3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO5	Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of Liquefaction processes	3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
OVERALL CO		3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3551 **MASS TRANSFER II** **L T P C**
3 0 0 3

OBJECTIVE:

The course is aimed to

- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

UNIT I ABSORPTION 9

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II DISTILLATION 9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 9

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV LEACHING 9

Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and countercurrent leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES 9

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.

CO2: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower

CO3: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process

CO4: Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation

CO5: Understand the concept of adsorption techniques, various isotherms and ion exchange Process and Formulate to solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes

TEXT BOOKS:

1. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill,2017.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

3. Wankat, P., “Equilibrium Stage Separations”, Prentice Hall, 1998.
4. B. K. Dutta.,”Mass Transfer and separation processes,Prentice Hall,2006

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edition, McGraw-Hill, 2017.
2. Seader J.D. and Henley E.J., “Separation Process Principles”, 2nd Ed., John Wiley, 2006.
3. King,C.J.,“SeparationProcesses“,2ndEdn.,TataMcGraw-Hill1980

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.	**3**	**2**	**2**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**
CO2	Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower	**3**	**3**	**3**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**
CO3	Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process	**3**	**3**	**3**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**
CO4	Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation	**3**	**3**	**1**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**
CO5	Understand the concept of adsorption techniques, various isotherms and ion exchange Process and Formulate to solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes	**3**	**2**	**1**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**
OVERALL CO		3	**3**	**2**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**3**	**3**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3511 COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVE:

The course is aimed to

- Solve chemical engineering problems form core courses using Excel, MATLAB, Polymath / problem solving software tool and chemical process simulation software tool.

Suggested Exercises

1. Friction factor, pressure drop, minimum fluidization velocity calculations
2. Settling velocity, drag coefficient, Reynolds number estimations
3. Equation of state, activity coefficient, VLE data, equilibrium conversion calculations
4. Empirical equation in fluid flow, heat and mass transfer operations
5. Solving a simple flow sheet by simultaneous approach
6. One, two and three dimensional heat conduction equations
7. Differential equation for reactors in series, non isothermal reactors, dispersion models, gravity tank
8. Partial differential equation involved in heat transfer, mass transfer, reaction engineering
9. First order and second order system in control system
10. Simulation of heat exchangers, Distillation, Absorber, Extraction column, reactors.
11. Simulation of process plant/simple flow sheet

Specific examples

1. Solving chemical Engineering Numerical problems (fluid flow, mechanical operations, heat transfer, mass transfer, thermodynamics and reaction Engineering problems) using Goal seek, solver, Regression function of Microsoft office Excel.
2. Solve simultaneous equation in chemical engineering by Matrix method using Microsoft office Excel.
3. Solve differential equation in chemical engineering by Runge Kutta method using Microsoft office Excel
4. Solving simultaneous equations, linear and non linear equations and differential equations in Chemical Engineering using problem solving software tool/Polymath
5. Solving Simultaneous equations, Differential equations and Partial differential Equations in Chemical Engineering using MATLAB.
6. Apply MATLAB Simulink tool to simulate Chemical process control systems with suitable examples.
7. Predictions thermodynamics properties using PROCESS SIMULATION SOFTWARE TOOL
8. Steady state simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL
9. Steady state simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL
10. Steady state simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL
11. Steady state simulation of an Absorption column using PROCESS SIMULATION SOFTWARE TOOL
12. Dynamic simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL
13. Dynamic simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL
14. Dynamic simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL

OUTCOMES:

On the completion of the course students are expected to

CO1: Solving chemical engineering problems using different tools available in the excel software.

CO2: Solving simultaneous equation and differential equation using polymath

CO3: Solving simultaneous equation and differential equation using Matlab

CO4: Simulation of simple chemical process with controller using simulink tool

CO5: Estimation of fluid property and understand the unit operation simulation using process simulation tool

TEXT BOOKS

1. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.
2. Michael B. Cutlip, Mordechai ShachamProblem Solving in Chemical and Biochemical Engineering with, Excel, and MATLAB, 2nd Edition, Prentice Hall, 2008

REFERENCES

1. Pradeep Ahuja Introduction to Numerical Methods in Chemical Engineering PHI New delhi, 2010
2. Amiya K.Jana, Process Simulation and Control using Aspen , PHI New delhi, 2012
3. H.S. Fogler, Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, 1999

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Solving chemical engineering problems using different tools available in the excel software.	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
CO2	Solving simultaneous equation and differential equation using polymath	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
CO3	Solving simultaneous equation and differential equation using Matlab	**3**	**3**	**3**	**3**	**3**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
CO4	Simulation of simple chemical process with controller using simulink tool	**3**	**3**	**3**	**3**	**3**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
CO5	Estimation of fluid property and understand the unit operation simulation using process simulation tool	**3**	**2**	**3**	**3**	**3**	**-**	**1**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**3**	**3**	**-**	**2**	**1**	**1**	**-**	**-**	**-**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3512	HEAT TRANSFER LABORATORY	L T P C
		0 0 3 1.5

OBJECTIVE:

The course is aimed to

- Develop sound practical knowledge for students on different types of heat transfer equipments

LIST OF EXPERIMENTS*

1. Measurement of Thermal Conductivity of metal rod
2. Performance studies on Cooling Tower
3. Batch drying kinetics using Tray Dryer
4. Heat transfer in Open Pan Evaporator
5. Boiling Heat Transfer
6. Heat Transfer through Packed Bed
7. Heat Transfer in a Double Pipe Heat Exchanger
8. Heat Transfer in a Bare and Finned Tube Heat Exchanger
9. Heat Transfer in a Vertical and Horizontal Condenser
10. Heat Transfer in Helical Coils
11. Heat Transfer in Agitated Vessels
12. Heat transfer studies in Stefan - Boltzmann apparatus

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.

CO2: Estimate the heat transfer rate and heat transfer co-efficient

CO3: To perform heat transfer operation and to compare observed with predicted performance.

CO4: Evaluate the performance/calculate the parameters in heat transfer equipments.

CO5: Collect and analyse the heat transfer data practically and Conduct experiments to solve complex engineering problems effectively as an individual as well as team work

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO2	Estimate the heat transfer rate and heat transfer co-efficient	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO3	To perform heat transfer operation and to compare observed with predicted performance	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO4	Evaluate the performance/calculate the parameters in heat transfer equipments.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO5	Collect and analyse the heat transfer data practically and Conduct experiments to solve complex engineering problems effectively as an individual as well as team work	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3561 **MASS TRANSFER LABORATORY** **L T P C**
0 0 3 1.5

OBJECTIVE:

The course is aimed to

- Develop sound practical knowledge for students on different types of mass transfer equipment’s

LIST OF EXPERIMENTS*

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Surface evaporation
10. Wetted wall column
11. Solid Liquid mass transfer studies
12. Water purification using ion exchange columns
13. Mass transfer characteristics of Rotating disc contactor
14. Estimation of mass/heat transfer coefficient for cooling tower
15. Demonstration of Gas – Liquid absorption

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the diffusivity practically and compare the results with the empirical correlations.
CO2: Estimate the mass transfer rate and mass transfer co-efficient
CO3: Evaluate the performance/calculate the parameters in different distillation processes
CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations
CO5: Estimate the drying characteristics

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	Program Outcomes															
CO1	Determine the diffusivity practically and compare the results with the empirical correlations.	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**
CO2	Estimate the mass transfer rate and mass transfer co-efficient	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**
CO3	Evaluate the performance/calculate the parameters in different distillation processes	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**
CO4	Evaluate the performance/calculate the parameters in leaching and extraction operations	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**
CO5	Estimate the drying characteristics	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3601 CHEMICAL REACTION ENGINEERING I

L	T	P	C
3	0	0	3

OBJECTIVE:

The course is aimed to

- Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, non-isothermal operation of reactors and gain knowledge about non ideal reactors.

UNIT I 9

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis. Half-life calculation. Temperature dependent rate expression.

UNIT II 9

Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, and size comparison of reactors.

UNIT III 9

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV 9

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V 9

The residence time distribution for chemical reactors, residence time functions and relationship between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the kinetics of homogenous reaction.

CO2: Develop performance equation and determine the conversion for different reactors.

CO3: Understand the reactor arrangement in series and parallel configuration.

CO4: Understand the design of reactor for multiple reactions.

CO5: Understand the non-isotherm operation of the reactor and gain knowledge on the residence time distribution function and analyze the non-ideality in the reactor.

TEXT BOOKS:

1. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 2006
2. H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008
3. Lanny D. Schmidth The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004

REFERENCES:

1. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013
2. G.Fronment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3 rd edition,2010
3. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**P O 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**P S O 2**	**P S O 3**
CO1	Understand the kinetics of homogenous reaction	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
CO2	Develop performance equation and determine the conversion for different reactors.	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
CO3	Understand the reactor arrangement in series and parallel configuration	**3**	**3**	**3**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
CO4	Understand the design of reactor for multiple reactions.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
CO5	Understand the non-isotherm operation of the reactor and gain knowledge on the residence time distribution function and analyze the non-ideality in the reactor	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3651 **PROCESS DYNAMICS AND CONTROL** **L T P C**
3 0 0 3

OBJECTIVE:

The course is aimed to

- Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

UNIT I **9**

Introduction to Chemical Process Control, Mathematical description of chemical processes, Formulating Process Models, Laplace Transforms, Properties of Laplace Transforms, Solution of ODE using Laplace Transforms, Standard input forcing functions, State – Space representation, transform domain models, Impulse response models, Inter relationship between process model forms

UNIT II **9**

Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag, FOPDT Model, Skogestaad's rule for FOPDT and SOPDT, Lead-Lag systems

UNIT III **9**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.

UNIT IV **9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion

UNIT V **9**

Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the need to develop mathematical description of a chemical process as a Prerequisite to process design and to control the process.

CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.

CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model.

CO4: Convert a process and instrumentation diagram to a control block diagram

CO5: Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.

TEXT BOOKS:

1. Stephanopoulos, G. (2015). Chemical process control, 3rd Ed New Jersey: Prentice hall.
2. Ogunnaike, B. A., & Ray, W. H. (1997). Process dynamics, modeling, and control (Vol. 1). New York: Oxford University Press.
3. Coughanowr, D. R., & Leblanc, S. E. (2017). Introductory concepts. Process Systems Analysis and Control, 3rd Ed, 1-6.

REFERENCES:

1. Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle IV, F. J. (2016). Process dynamics and control. John Wiley & Sons.
2. Bequette, B. W. (2003). Process control: modeling, design, and simulation. Prentice Hall Professional.
3. Riggs, J. B., & Karim, M. N. (2007). Chemical and Bio-process Control: James B. Riggs, M. Nazmul Karim. Prentice Hall.
4. Luyben, W. L., Tyréus, B. D., &Luyben, M. L. (1998). Plantwide process control (Vol. 43). New York: McGraw-Hill.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the need to develop mathematical description of a chemical process as a prerequisite to process design and to control the process.	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
CO2	Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO3	Represent a physical system using FOPDT model and estimate parameters in FOPDT model.	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO4	Convert a process and instrumentation diagram to a control block diagram	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO5	Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**-**	**2**	**2**	**2**	**2**	**3**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NCC Credit Course Level 3*

NX3651 **(ARMY WING) NCC Credit Course - III** **L T P C**
3 0 0 3

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Team Work	2
PD 4	Career Counselling, SSB Procedure & Interview Skills	3
PD 5	Public Speaking	4
BORDER & COASTAL AREAS		**4**
BCA 2	Security Setup and Border/Coastal management in the area	2
BCA 3	Security Challenges & Role of cadets in Border management	2
ARMED FORCES		**3**
AF 2	Modes of Entry to Army, CAPF, Police	3
COMMUNICATION		**3**
C 1	Introduction to Communication & Latest Trends	3
INFANTRY		**3**
INF 1	Organisation of Infantry Battalion & its weapons	3
MILITARY HISTORY		**23**
MH 1	Biographies of Renowned Generals	4
MH 2	War Heroes - PVC Awardees	4
MH 3	Study of Battles - Indo Pak War 1965, 1971 & Kargil	9
MH 4	War Movies	6

TOTAL: 45 PERIODS

NCC Credit Course Level 3*

NX3652 **(NAVAL WING) NCC Credit Course - III** **L T P C**
3 0 0 3

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Team Work	2
PD 4	Career Counselling, SSB Procedure & Interview Skills	3
PD 5	Public Speaking	4
BORDER & COASTAL AREAS		**4**
BCA 2	Security Setup and Border/Coastal management in the area	2
BCA 3	Security Challenges & Role of cadets in Border management	2
NAVAL ORIENTATION		**6**
NO 3	Modes of Entry - IN, ICG, Merchant Navy	3
AF 2	Naval Expeditions & Campaigns	3
NAVAL COMMUNICATION		**2**
NC 1	Introduction to Naval Communications	1
NC 2	Semaphore	1
NAVIGATION		**2**
N 1	Navigation of Ship - Basic Requirements	1
N 2	Chart Work	1
SEAMANSHIP		**15**
MH 1	Introduction to Anchor Work	2
MH 2	Rigging Capsule	6
MH 3	Boatwork - Parts of Boat	2
MH 4	Boat Pulling Instructions	2
MH 5	Whaler Sailing Instructions	3
FIRE FIGHTING FLOODING & DAMAGE CONTROL		**4**
FFDC 1	Fire Fighting	2
FFDC 2	Damage Control	2

SHIP MODELLING		**3**
SM	Ship Modelling Capsule	3
		TOTAL : 45 PERIODS

NCC Credit Course Level 3*

NX3653	**(AIR FORCE WING) NCC Credit Course Level - III**	**L T P C** **3 0 0 3**

PERSONALITY DEVELOPMENT		**9**
PD 3	Group Discussion: Team Work	2
PD 4	Career Counselling, SSB Procedure & Interview Skills	3
PD 5	Public Speaking	4
BORDER & COASTAL AREAS		**4**
BCA 2	Security Setup and Border/Coastal management in the area	2
BCA 3	Security Challenges & Role of cadets in Border management	2
AIRMANSHIP		**1**
A 1	Airmanship	1
BASIC FLIGHT INSTRUMENTS		**3**
FI 1	Basic Flight Instruments	3
AERO MODELLING		**3**
AM 1	Aero Modelling Capsule	3
GENERAL SERVICE KNOWLEDGE		**2**
GSK 4	Latest Trends & Acquisitions	2
AIR CAMPAIGNS		**6**
AC 1	Air Campaigns	6
PRINCIPLES OF FLIGHT		**6**
PF 1	Principles of Flight	3
PF 2	Forces acting on Aircraft	3
NAVIGATION		**5**
NM 1	Navigation	2
NM 2	Introduction to Met and Atmosphere	3
AERO ENGINES		**6**
E 1	Introduction and types of Aero Engine	3
E 2	Aircraft Controls	3
		TOTAL : 45 PERIODS

CH3611 CHEMICAL REACTION ENGINEERING LABORATORY

L	**T**	**P**	**C**
0	**0**	**3**	**1.5**

OBJECTIVE:

The course is aimed to

- Develop sound practical knowledge for students on different types of reactors.

LIST OF EXPERIMENTS*

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Kinetic studies in Sono chemical reactor
12. Studies on Cascade CSTR
13. Kinetics of photochemical reaction
14. Demonstration of heterogeneous catalytic reaction
15. Demonstration of gas-liquid reaction
16. Kinetics study in Adiabatic reactor
17. Determination of Activation Energy of a reaction
18. Kinetic study in semi batch reactor

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the rate constant experimentally in a batch reactor.

CO2: Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)

CO3: Study of temperature dependence of rate constant.

CO4: Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.

CO5: Determine the conversion of reactor arranged in series and the rate constant using sono and photo chemical reactors.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Determine the rate constant experimentally in a batch reactor.	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO2	Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO3	Study of temperature dependence of rate constant.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO4	Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
CO5	Determine the conversion of reactor arranged in series and the rate constant using sono and photo chemical reactors.	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3612 PROCESS EQUIPMENT DESIGN AND DRAWING **L T P C**
0 0 3 1.5

OBJECTIVE:

- Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipments

UNIT I
Heat Exchangers, Condensers, Evaporators

UNIT II
Cooling Tower, Dryers

UNIT III
Absorption column, Distillation Column, Extraction Column, Adsorption column

UNIT IV
Packed bed Reactors, Pressure Vessel, Storage Vessel

UNIT V
Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation
Materials of Construction and Selection of process equipments

TOTAL : 45 PERIODS

OUTCOMES:

CO1: Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA
CO2: Design Cooling towers and evaporators and design evaporators and crystallizer
CO3: Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors
CO4: Calculate the design specifications of packed bed reactor and storage vessels, bins and silos
CO5: Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
CO2	Design Cooling towers and evaporators and design evaporators and crystallizer	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO3	Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**

CO 4	Calculate the design specifications of packed bed reactor and storage vessels, bins and silos	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO 5	Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
OVERALL CO		**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3712 INDUSTRIAL TRAINING / INTERNSHIP II## **L T P C**
0 0 0 1

OBJECTIVES:
To enable the students to
- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.
No. of. Weeks: 02

OUTCOMES:
On completion of the course, the student will know about
CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute
CO2: Analysis of industrial / research problems and their solutions
CO3: Documenting of material specifications, machine and process parameters, testing parameters and results
CO4: Preparing of Technical report and presentation

CH3701 CHEMICAL REACTION ENGINEERING II **L T P C**
3 0 0 3

OBJECTIVE:
The course is aimed to
- Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.

UNIT I **9**
Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single

and Mixed Sizes, design of fluid –particle reactors.

UNIT II **9**

Catalysis and adsorption: physical properties of catalyst, surface area, void volume, solid density, volume determination, catalyst classification and preparation, catalyst promoters, catalyst inhibitors, catalyst poisons. Adsorption Isotherms Freundlich and Langumir isotherms.

UNIT III **9**

Gas solid catalytic reaction: steps in catalytic reaction, Single site, dual site mechanisms, Langmuir Hinshelwood, EleyRideal, Rate controlling steps. Experimental methods for determining rate, differential, integral reactor and reactor deign.

UNIT IV **9**

Diffusion within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non isothermal condition.

UNIT V **9**

Fluid Fluid reaction. Kinetics and design of Fluid- Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction ,Factors to select the contactor, Tower Reactor Design.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the gas solid non catalytic reaction and different models for non catalytic reaction.

CO2: Understand catalyst, catalyst preparation, property estimation and isotherm study.

CO3: Understand the gas solid catalytic reaction and their mechanism

CO4: Design of catalytic reactor for gas solid reaction.

CO5: Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design

TEXT BOOKS:

1. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981
2. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 2006
   H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008

REFERENCES:

1. Lanny D. Schmidt The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004
2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013
3. G.F. Froment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3rd edition,2010.

COURSE ARTICULATION MATRIX

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the gas solid non catalytic reaction and different models for non catalytic reaction.	**3**	**3**	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO2	Understand catalyst, catalyst preparation, property estimation and isotherm study	**3**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO3	Understand the gas solid catalytic reaction and their mechanism	**3**	**3**	**3**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO4	Design of catalytic reactor for gas solid reaction.	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
CO5	Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design	**3**	**2**	**3**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3702 **TRANSPORT PHENOMENA** **L T P C**
3 0 0 3

OBJECTIVE:

The course is aimed to

- Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.

UNIT I MOMENTUM TRANSPORT 9

Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II ENERGY TRANSPORT 9

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT III MASS TRANSPORT 9

Diffusivity, temperature and pressure effect on diffusivity, Fick's law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst.

UNIT IV EQUATIONS OF CHANGE AND THEIR APPLICATIONS 9

Momentum: Equations of continuity, motion and mechanical energy (Isothermal), Energy: Equation of energy (non-isothermal). Mass: Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component). Solutions of momentum, heat and mass transfer problems discussed under shell balance by applications of equation of change, dimensional analysis of equations of change.

UNIT V TRANSPORT IN TURBULENT FLOWS AND ANALOGIES 9

Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.

TOTAL: 45 PERIODS

OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.

CO2: Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.

CO3: Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.

CO4: Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.

CO5: Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.

TEXT BOOKS:

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. W., "Transport Phenomena", 2nd Edn., John Wiley, 2006
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1987

REFERENCES:

1. Welty, J. R., Wilson, R. W., and Wicks, C. W., "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition. John Wiley, New York,2008.
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999.
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1993.

COURSE ARTICULATION MATRIX:

Course Outcomes	Program Outcomes															
	Statements	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**-**
CO2	Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**3**	**-**
CO3	Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**3**	**-**
CO4	Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**3**	**-**
CO5	Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**3**	**-**
OVERALL CO		**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

GE3791 HUMAN VALUES AND ETHICS L T P C
2 0 0 2

COURSE DESCRIPTION

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

COURSE OBJECTIVES:

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I DEMOCRATIC VALUES 6

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.
Reading Text: Excerpts from John Stuart Mills' *On Liberty*

UNIT II SECULAR VALUES 6

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from *Secularism in India: Concept and Practice* by Ram Puniyani

UNIT III SCIENTIFIC VALUES 6

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

Reading Text: Excerpt from *The Scientific Temper* by Antony Michaelis R

UNIT IV SOCIAL ETHICS 6

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from *21 Lessons for the 21st Century* by Yuval Noah Harari

UNIT V SCIENTIFIC ETHICS 6

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

TOTAL: 30 PERIODS

REFERENCES:

1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,

5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

COURSE OUTCOMES

Students will be able to

CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2 : Practice democratic and scientific values in both their personal and professional life.

CO3 : Find rational solutions to social problems.

CO4 : Behave in an ethical manner in society

CO5 : Practice critical thinking and the pursuit of truth.

CH3711 PROCESS CONTROL LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVE:

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level system
4. Response of Interacting level system
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system
17. Optimum Controller Tuning using Ziegler Nichols method

*Minimum 10 experiments shall be offered.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to

CO1 Able to determine the response of a first order and second order system for various input

CO2 Able to determine the response of a interacting and non- interacting system for various input

CO3 Understand the difference between an open loop and closed loop system

CO4 Understand the concept of three classical controller P, PI, PID controller

CO5 Understand the concept of stability and tuning of a system

Course Articulation matrix

Course Outcomes	Statements	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	Program Outcomes															
CO1	Able to determine the response of a first order and second order system for various input	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO2	Able to determine the response of a interacting and non-interacting system for various input	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO3	Understand the difference between an open loop and closed loop system	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO4	Understand the concept of three classical controller P, PI, PID controller	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	Understand the concept of stability and tuning of a system	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
OVERALL CO		3	3	2	3	3	2	1	1	1	1	1	1	2	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3811 PROJECT WORK / INTERNSHIP# **L T P C**
0 0 20 10

OBJECTIVES:

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

TOTAL: 300 PERIODS

OUTCOMES:

At the end of the project, the student will be able to

CO1: Formulate and analyze problem / create a new product/ process.

CO2: Design and conduct experiments to find solution

CO3: Analyze the results and provide solution for the identified problem, prepare project report and make presentation.

PEC- Petroleum Process Technology

CH3001 PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS **L T P C**
3 0 0 3

OBJECTIVE

The course is aimed

1) To enable the students to learn the fundamental and methodologies in the petroleum refining processes.
2) To enable students to examine how each refinery process works
3) To enable students to express the objectives of petroleum refining and classify the processes used in petroleum refining
4) To enable students learn how physical and chemical principles are applied to achieve the objectives of each refinery process

UNIT I CRUDE CHEMISTRY AND PRODUCTS 9

Origin, Formation and Evaluation of Crude Oil -Indian petroleum industries- types of Hydrocarbon -composition of crude oil (PONA,S,N2 etc) -Thermo-physical and physical properties of crude oil-petroleum standards- chemical analysis data- Testing methods of petroleum products-Chemical quality of products-Types of crude-Crude assay- selection of crude based on product yield.

UNIT II BASICS FOR REFINING 9

Properties of gas-Ideal gas laws-partial pressure-specific gravity-density-Properties of liquid-viscosity and index-boiling point-pressure of fluid at rest-flow resistance-static/induced pressure-specific/latent heat/condensation-modes of heat transfer-diffusion mass transfer-properties of solid

UNIT III PETROLEUM THERMODYNAMICS AND CALCULATION 9

First/second law-behavior of gas and liquid – PVT relationship- equation of state-VLE- equilibrium constant-Multi component liquid vapor composition calculation-specific gravity calculation-TBP distillation-ASTM-conversion to pseudo-components-Molecular weight calculation-pseudo-critical properties-calculation of enthalpy of petroleum fractions-Generalized equation for thermo physical properties of petroleum.

UNIT IV REFINERY UNIT OPERATIONSAND CALCULATION 9

Distillation-types-column internals-multi component distillation-relative volatility- azeotropic mixture- absorption- desorption- adsorption- refrigeration - extraction- drying curve-humfidication principle- crystallization-stripping operation-.boiling curve- application of all operation in refinery and its basic design calculations.

UNIT V REFINERY PROCESSES AND CATALYST FUNDAMENTAL 9

Treating processes of petroleum products- Thermal/catalytic/hydo cracking-reforming/ isomerization /alkylation -principles and reactions- Catalyst phenomenon and theory- surface area/void volume/porosity- catalyst classification and preparation/selectivity/yield/reactivity-heterogeneous reactions- catalytic reactor types (packed bed/moving bed/fluidized bed)-residence time-space velocity- Catalyst loading techniques

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

CO2: Understand the insights of primary treatment processes to produce the precursors.

CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes and Learn the importance of optimization of process parameters for the high yield of petroleum products.

TEXT BOOKS

1. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
2. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
3. The Chemistry and technology of Petroleum, James G. Speight, CRC Press, taylor& Francis Group
4. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000
5. Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaisbupetrolepublications,France 2003.
6. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdition, McGraw-Hill,2005.
7. Treybal,R.E.,"MassTransferOperations",3rdEdn.,McGraw-Hill,1981.

REFERENCES

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
2. J. H. Gary, H. Hanwerk and M. J. Kaiser,,, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007
3. Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988
4. R.N. Watkin, "Petroleum Refinery Distillation", Gulf Publishing Co, Houstan, Texas, USA, 2nd edition, 1981
5. Handbook of Petroleum Analysis, James G. Speight, Wiley-Interscience, John Wiley & Sons, Inc., Publications
6. Holland, C. D. (1963). Multicomponent distillation. Prentice-Hall.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.	1	1	2	1	-	1	1	1	1	1	1	2	2	1	1
CO2	Understand the insights of primary treatment processes to produce the precursors.	2	1	1	1	2	1	1	1	1	1	2	2	2	1	1
CO3	Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.	1	1	2	1	2	1	-	1	1	1	1	1	2	1	1
CO4	Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products	1	2	2	2	1	1	2	2	2	1	2	1	2	2	2
CO5	Understand the societal impact of petrochemicals and learn their manufacturing processes. and Learn the importance of optimization of process parameters for the high yield of petroleum products	1	2	2	1	1	1	1	2	2	-	1	1	2	1	2
	Overall CO	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3002 PRIMARY REFINING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course is aimed

1) To enable the students to learn the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.
2) To enable students to examine how each refinery process works
3) To enable students learn each operating variables are applied to achieve the objectives of each refinery process

UNIT I FEED PREPARATION 9

Pipelines from port to tank farm -safety and regulations -storage techniques in crude oil-impurities removal- measuring by dipping -spiking techniques -types of salts in crude - desalting process – electric desalter- preheating train and design- furnace and its operation.

UNIT II ATMOSPHERIC DISTILLATION 9

Operation and process description of ADU-design characteristics of ADU tower-cutpoints-degree of fractionation-over flash-column pressure and overhead temperature- Preflash system-overhead system-side streams-intermediate pump around and reflux systems- Refinery off gas – LPG treatment-Naphtha stabilizer and splitter-side stripping sections-operating variables

UNIT III VACUUM DISTILLATION 9

Operation of VDU- Need of vacuum- ejectors and its types/principle- Overhead ejector system-flash zone- draw off temperature- internal flow in VDU- light/middle/heavy cuts- routing to secondary units- lube based treatments-packing section tower loading of VDU

UNIT IV LUBE OIL BASE STOCKS 9

Viscosity index calculation and pour point - LOBS processing by solvent treatment and hydro treatment- solvent selection-solvent extraction by NMP,furfural,- MEK solvent dewaxing/-refrigerating and filtration -hydro finishing- types of LOBS based on VI- types or groups of lube processing-spindle/LN/IN/HN/BN processing and blending.

UNIT V ASPHALT AND WAX TECHNOLOGY 9

Vacuum residue properties- propane deasphalting-asphalt processing and types-chemical structure-air blowing of bitumen- slack wax processing- wax and types/properties- wax deoiling-unit operations in wax plants- refrigerating and filtration/ hydro treating of wax- molding and storage

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.

CO2:understand how each refinery process works

CO3:learn the operating variables which are applied to achieve the objectives of each refinery process

CO4: Understand the methodologies of processing and blending

CO5: Apply the concepts in asphalt processing and wax treatment technology

TEXT BOOKS:

1) Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
2) Prasad, R., “Petroleum Refining Technology”, Khanna Publishers, New Delhi, 2000
3) W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
4) J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007

5) Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES

1) J.G. Speight and B. Ozum, “Petroleum Refining Processes”, Marcel Dekker Inc, New York, 2002
2) G.D. Hobson, “Modern Petroleum Technology”, Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3) David.S.J.”STAN”Jones and Peter R.Pujado “Handbook of Petroleum Processing,Springer,2006.
4) Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.	2	1	1	1	-	1	2	2	2	1	-	1	1	1	2
CO2	understand how each refinery process works	2	1	2	1	2	1	2	1	2	1	1	1	1	1	1
CO3	learn the operating variables which are applied to achieve the objectives of each refinery process	2	1	2	1	2	1	2	1	2	1	1	1	2	2	2
CO4	Understand the methodologies of processing and blending	2	1	2	2	2	1	2	1	2	1	1	1	1	-	-
CO5	Apply the concepts in asphalt processing and wax treatment technology	2	1	2	2	2	2	2	1	2	1	1	1	2	1	1
Overall CO		2	1	1	1	1	2	2	1	2	1	1	1	1	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3003 SECONDARY REFINING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course is aimed

1. To enable the students to learn the methodologies in the secondary petroleum refining or upgrading processes like thermal cracking, coking, catalytic cracking, hydrocracking ,hydro treating, reforming, isomerization, alkylation and sulfur finishing processes
2. To enable students to learn refinery operation on FCC, Vis breaker, DCU, Reformer, etc. and operation on utilities like steam, cooling water, instrument air, H2, N2 etc.
3. To enable students learn each operating variables of all units

UNIT I THERMAL CRACKING AND COKING 9

Resid upgradation technologies- cracking-thermal cracking-mechanism/principle/reactions-process variables- Visbreaking- soaker process- coil visbreaker-Disadvantages-Coking-thermodynamics and mechanism of coking-delayed coking-operation-fluid coking-flexicoking-types of coke and properties- yield pattern of cracking and coking

UNIT II CATALYTIC CRACKING 9

Principles of catalytic cracking-mechanisms- FCC- main reaction of FCC- role of FCC in refinery-Fluidization- feedstocks/products/yield pattern- Kinetics and thermodynamics of FCC reactions-FCC catalyst and licensor technologies- reaction/regeneration/fractionation sections-slide valves and its importance- riser/cyclone separator/reactor internals-RFCC/MSCC/Petro FCC

UNIT III HYDROGEN AND HYDROCONVERSION 9

H2 requirements-steam reforming and shift conversion-operation and thermodynamics of reformer and NI catalyst-Hydro treatment processes- catalyst and reaction chemistry-Naphtha/Diesel/lube/wax/gasoline hydro treatment-Hydrocracking process- Typical hydrocracker in refinery- catalyst/severity/conversion/Temperature profile for yield pattern-reaction kinetics of hydrocracker- Operation and variables

UNIT IV REFORMING/ISOMERISATION/ALKYLATION 9

Reforming feed index-RON-various reforming technologies-platforming reactions-kinetics and thermodynamics of Pt catalyst reactions-Operation in Straight Run and Continuous Run mode-yield calculation- Isomerization techniques- reactions and kinetics- various technologies in isom-importance of catalyst-hexane production-Alkylation process-reactions – various alkylation processes- process variables in reforming/isom/alky
.

UNIT V FINISHING PROCESSES AND UTILITIES 9

Sources of sulfur in refinery-types of sulfur compounds in crude-sweetening processes- various sulfur treatment process in products-H2S properties and removal by physical and chemical process- Amine selection –amine absorption and regeneration-sour water stripping- Merox process- Sulfur recovery from H2S by Claus /super Claus/ modified Claus technology/SCOT Process/CS2 process; Electricity and steam generation by Gas turbine/boiler-Cooling tower operation-Fuel oil-Cryogenic distillation of air to N2 and O2 production- Instrument air operation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1 – acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydrocracking.
CO2 – understand the operation on FCC, Vis breaker, DCU, Reformer.
CO3 - helps to understand the operation on utilities like steam, cooling water, instrument air, H2, N2.
CO4 – understand the basic knowledge on isomerisation, alkylation and reforming process.
CO5 – gather some knowledge in the finishing processes and their operations in refining industries.

TEXT BOOKS:

1. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
2. Prasad, R., “Petroleum Refining Technology”, Khanna Publishers, New Delhi, 2000
3. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
4. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007
5. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES

1. J.G. Speight and B. Ozum, “Petroleum Refining Processes”, Marcel Dekker Inc, New York, 2002
2. G.D. Hobson, “Modern Petroleum Technology”, Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3. David.S.J.”STAN”Jones and Peter R.Pujado “Handbook of Petroleum Processing, Springer,2006.
4. Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydrocracking	2	2	1	1	2	2	2	2	2	1	2	1	1	2	1
CO2	understand the operation on FCC, Vis breaker, DCU, Reformer.	1	2	1	2	2	2	2	1	1	2	2	2	1	1	1
CO3	helps to understand the operation on utilities like steam, cooling water, instrument air, H_2, N_2.	2	1	1	2	2	2	1	2	2	2	2	1	1	2	2
CO4	understand the basic knowledge on isomerisation, alkylation and reforming process.	1	2	1	1	2	1	1	2	1	2	2	1	1	1	2
CO5	gather some knowledge in the finishing processes and their operations in refining industries	1	1	1	1	2	2	1	1	2	1	1	2	1	1	2
Overall CO		1	1	1	1	2	2	1	1	1	1	1	1	1	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3004 REFINERY ADVANCEMENTS AND ENVIRONMENTAL REGULATIONS **L T P C**
3 0 0 3

OBJECTIVE

The course is aimed

- To enable the students to learn the advanced techniques, automation, units integration and instrumentation techniques in refinery.
- To enable students to understand the environmental regulations, safety and government policies on refinery
- To enable students learn the energy saving techniques and refinery economics.

UNIT I ENVIRONMENTAL REGULATION AND GOVERNMENT POLICIES 9

Classes of petroleum based on flash point- storage tank design- GAS/LIQUID/SOLID wastes form refinery units-environmental standards on air and water pollution and control-Solid waste management- Sludge conditioning and treatment and disposal- Effluent treatment plant-TTP-greenhouse gases-Bharat stages and its regulations- Recent modification for BS-6- Policies on biofuel-EBP-Bio-diesel

UNIT II CORROSION AND SAFETY 9

Corrosion- reaction and types- refinery corrosion tests- controlling parameters- corrosion control in equipment and pipelines-Types of fire- Safety triangle- Firefighting equipment-PPE- HAZOP studies- Petroleum disasters case study- process safety protocol- pressure relief systems- flare systems- CBD/OWS- MSDS for units- oil spilling and skimming

UNIT III ADVANCEMENTS IN REFINERY 9

Instrumentation- Flow/pressure/temperature/level transmitter-Control systems and logics – controller types- mode of controllers- cascade, split range, ratio etc. - P/PI/PID controllers and control tuning-process optimization by APC/DMC- DCS/PLC systems

UNIT IV REFINERY UNIT INTEGRATION AND RECENT TRENDS 9

.Overall modern refinery flow sheet- products routing- naphtha utilization route up and integration- Diesel/gasoline/ATF/kerosene route up to blending header- Blending processes-line blending- Blending of diesel and MS calculation- LP model for blending operation- Recent trends in ADU with pre flash- RFCC-OHCU-Prime G+-catalytic dewaxing- PSA technology-DWC technology- Blue H2 process-Pre reforming- moving bed in CRU and isom-Advanced lube processing

UNIT V ENERGY SAVING AND REFINERY ECONOMICS 9

Furnace efficiency calculation-steam utilization- plume length- insulation of pipelines- heat tracing-steam traps-Standard Refinery Fuel Tonnage- Fuel and loss- operational cost- margin cost- refining capacity-complexity factor- crude oil evaluation and procurement-monthly production planning- cracks-Gross Refinery Margin-operation optimization by Linear Programming model-shutdown planning- Refinery Transfer Price-taxation-pricing

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – understanding the regulations and government policies in refining industries.

CO2 – acquire some knowledge on advanced techniques, automation and instrumentation techniques.

CO3 – understand the different controllers and automated control systems in refineries.

CO4 – gathers knowledge on unit integrations in refineries.

CO5 – understand the basis on energy saving techniques and refinery economics

TEXTBOOKS:

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
2. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007

3. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
4. Coughanowr, D. R., & Leblanc, S. E. (2008). Introductory concepts. Process SystemsAnalysisandControl, 3rd Ed, 1-6.
5. Industrial Instrumentation, Donald P.Eckman, CBS, 2004.
6. Smith,R.(2005).Chemical process:design and integration. JohnWiley&Sons.
7. Corrosion Control in the Oil and Gas Industry 1 st Edition, Sankara Papavinasam, 2013
8. Gilbert, M. Masters., "Introduction to Environmental Engineering and Science", 3rd edition 2008

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1. Luyben, W. L., Tyréus, B. D., &Luyben, M. L. (1998). Plant wide process control (Vol. 43). New York: McGraw-Hill.
2. Stephanopoulos, G. (1984). Chemical process control (Vol. 2). New Jersey: Prentice hall.
3. Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice -Hall India , 2000
5. Petroleum Economics, Jean Masseron, Technip; 4threvised Edition, 2000. (ISBN-10: 2710805979; ISBN-13: 978-2710805977)
6. Cheremisinoff N.P. and Graffia M.L., "Environmental Health and Safety Management. A Guide to Compliance", Pressure safety de-sign practices for refinery and chemical operations", Jaico Publica-tion. 2003
7. Fontana, M.G., "Corrosion Engineering", Edn 3, McGraw Hill, 1989

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understanding the regulations and government policies in refining industries.	1	1	1	1	1	2	2	1	2	1	2	2	2	2	1
CO2	acquire some knowledge on advanced techniques, automation and instrumentation techniques	1	1	1	1	1	2	2	1	2	2	2	2	1	2	1
CO3	understand the different controllers and automated control systems in refineries.	1	2	1	2	1	2	2	1	2	1	2	2	1	2	1
CO4	gathers knowledge on unit integrations in refineries.	2	2	1	2	2	2	2	1	2	1	1	2	1	2	1
CO5	understand the basis on energy saving techniques and refinery economics	2	2	1	2	2	2	2	2	2	1	1	2	1	2	1
Overall CO		1	1	1	1	1	2	2	1	2	1	1	1	1	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE3591 PETROLEUM EQUIPMENT DESIGN

	L	T	P	C
	3	**0**	**0**	**3**

OBJECTIVE:

- To study and analyze suitable equipment for particular reservoir conditions.

UNIT I ***9***

Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating, hydraulic fracturing. DRILL BIT DESIGN.ROLLER CONE BITS.PDC DRILL BITS.NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP(Electrical submersible pumps). SRP(Sucker rod pumping) unit design.

UNIT II **9**

Design of Surface Facilities -Design of production and processing equipment, including separation problems, treating, and transmission systems.

UNIT III **9**

Capstone design in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.

UNIT IV **9**

Oil desalting-horizontal and spherical electrical dehydrators- Natural Gas Dehydration-Horton sphere- Natural Gas Sweetening. Crude & Condensate Stabilization-design of stabilizer- Oil and Gas Treatment. Treating Equipment**.**

UNIT V **9**

Refinery Equipment Design-atmospheric distillation column Design and construction of on/ offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation..

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to

CO1 Understand the drill bit fundamentals, codes and standards
CO2 Understand design of production and processing equipment.
CO3 Understand the Capstone design in reservoir engineering.
CO4 Understand the design ofOil and Gas Treatment Equipment
CO5 Understand the design ofpipe systems.

TEXT BOOKS:

1. Petroleum Exploration Hand Book by Moody, G.B.
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

REFERENCE:

1. Standard Hand Book of Petroleum & Natural Gas Engineering” – 2nd Edition 2005-William C.Lyons& Gary J.Plisga-Gulf professional publishing comp (Elsevier).

Course Articulation matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Understand the drill bit fundamentals, codes and standards	3	2	-	2	-	-	2	2	-	-	3	-	3	-	-	2
CO2	Understand design of production and processing equipment.	3	2	3	3	2	-	3	-	-	-	-	-	3	-	2	2
CO3	Understand the Capstone design in reservoir engineering .	3	2	3	-	2	-	2	-	-	2	-	-	3	1	-	3
CO4	Understand the design of Oil and Gas Treatment Equipment	3	2	3	2	-	-	3	-	-	-	1	-	3	-	-	2
CO5	Understand the design ofpipe systems.	3	3	3	-	3	-	2	-	-	-	-	-	3	-	-	3
Overall CO		3	2	3	2	2	-	2	2	-	2	3	-	3	1	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3005 PETROCHEMICAL TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

The course is aimed

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I PETROCHEMICALS EVOLUTION 9

Petrochemical Industries and their feedstock selection .History, Economics, Growth of petrochemical industry.-structure of Petrochemical complexes- Classification of petrochemicals- Basic building processes- Integration with refinery-flow scheme

UNIT II INTERMEDIATES FOR PETROCHEMICALS INDUSTRIES 9

Production Methods - Reforming and cracking of feed stocks; Sources: Chemicals from synthesis gas, olefins and aromatics-Ethylene, Propylene, C_4hydrocarbons, higher olefins, Benzene, Toluene, Xylene and their derivatives

UNIT III COMPLEX PETROCHEMICAL PRODUCTS 9

Acrylonitrile, Acrylic acid, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline – Process flow scheme- various technology- advantages-yield pattern-process variables

UNIT IV POLYMERS 9

Polymers production: Fibers, Rubbers and Plastics. Acrylonitrile butadiene styrene (ABS), polyethylene-LDPE, HDPE, Polypropylene, PVC, PS, SAN, SBR, PAN, Nylon and Polycarbonates.

UNIT V GLOBAL CHEMICALS 9

Petrochemicals-Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, detergents, paint, healthcare and pharmaceuticals, Fertilizers-Ammonia, Urea, NPK etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – able to understand the basic knowledge on petrochemical industry and their growth, history.

CO2 – understand the different methods of production in petrochemical products and their derivatives.

CO3 – gather knowledge on the production of complex petrochemical products

CO4 - able to understand the petrochemical industries and its application with production techniques in polymers.

CO5 – to understand the application of petrochemicals in all process fields

TEXTBOOKS

1. Bhaskara Rao,B.K."ATextonPetrochemicals",2nd Edition, Khanna Publishers, NewDelhi,1998
2. H. Steiner, "Introduction to petrochemicals", Pergamon Press, NewYork, 1961.
3. Wiseman.P.,"Petrochemicals",UMIST Series in Science and Technology, John Wiley &Sons,1986.
4. IDMall,'Petrochemical process Technology',Macmillan India Limited,2007.
5. A. Chawvel and G. Lefebvre, "Petrochemical Process", Vol. I & II, Gulf Publishing Co., Houston, London

REFERENCES

1. BrownsteinA.M.'TrendsinPetrochemicalTechnology',Petroleum Publishing Company, 1976.
2. G.MargaretWells,'HandbookofPetrochemicalsandProcesses'2nd Revised Edition, Gower Publishing Company.
3. Groogins, “Unit Process in Organic Synthesis”, McGraw Hill Book Company, New York
4. Robert A. Meyers, “Handbook of Petrochemicals Production Processes”, McGraw-Hill Education: New York, 2 nd edition, 2019 (ISBN: 9781259643132)
5. L.F. Hatc and MatarSarri, “From Hydrocarbons to Petrochemicals”, Gulf Publishing Co., Houston, London
6. A.L. Waddams, “Chemicals from Petroleum”, Gulf Publishing Company, London, 4th edition, 1980

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	able to understand the basic knowledge on petrochemical industry and their growth, history.	2	1	2	1	2	2	1	2	2	1	1	1	2	2	1
CO2	understand the different methods of production in petrochemical products and their derivatives	2	2	1	1	2	2	1	2	2	2	1	1	2	2	2
CO3	gather knowledge on the production of complex petrochemical products	2	2	1	1	2	2	1	2	2	1	1	1	2	2	1
CO4	able to understand the petrochemical industries and its application with production techniques in polymers.	2	2	2	1	2	2	1	1	3	1	2	1	2	2	1
CO5	to understand the application of petrochemicals in all process fields	1	2	1	1	2	2	1	1	3	1	2	1	2	2	1
Overall CO		2	2	1	1	2	2	1	1	2	1	1	1	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3006 **BIOENERGY** **L T P C**
3 0 0 3

UNIT I **9**

Biomass sources and classification; Biomass characteristics & preparation; Chemical composition and properties of biomass; Size reduction, Briquetting of loose biomass, Drying, Storage and handling of biomass.

UNIT II **9**

Biogas technology: Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Dry and wet fermentation, Digestors for rural application-High rate digesters for industrial waste water treatment.

UNIT III **9**

Pyrolysis and thermo-chemical conversion: Thermo-chemical conversion of lignocellulosic biomass. Incineration for safe disposal of hazardous waste, Biomass processing for liquid fuel production, Pyrolysis of biomass-pyrolysis regime, effect of particle size, temperature, and products obtained.

UNIT IV **9**

Gasification of biomass: Thermochemical principles: Effect of pressure, temperature and introducing steam and oxygen. Design and operation of Fixed and Fluidised Bed Gasifiers, Safety aspects.

UNIT V **9**

Combustion of biomass and cogeneration systems: Combustion of woody biomass-theory, calculations and design of equipment, Cogeneration in biomass processing industries. Case studies: Combustion of rice husk, Use of bagasse for cogeneration.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on classification, characterization and sources of biomass
CO2- learn the production of biogas
CO3- gather knowledge on the operations of incineration, pyrolysis.
CO4- understand the process in gasification of biomass
CO5- knowledge on the types of combustion of biomass.

TEXT BOOKS

1. Anju Dahiya, Bioenergy: Biomass to biofuels First Edition, Academic Press, 2014.
2. Li, Yebo, and Samir Kumar Khanal. Bioenergy: principles and applications. John Wiley & Sons, 2016.

REFERENCE BOOKS

1. Vaughn C Nelson, Kenneth L. Starcher. Introduction to bioenergy. CRC Press, 2017.
2. Wall, Judy D., Caroline S. Harwood, and Arnold Demain. "Bioenergy." Bioenergy.. ASM Press, 2008.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the fundamental knowledge on classification, characterization and sources of biomass	2	1	2	1	2	1	2	2	1	1	1	1	2	1	2
CO2	learn the production of biogas	2	-	2	1	2	1	2	2	1	1	1	2	2	2	2
CO3	gather knowledge on the operations of incineration, pyrolysis.	2	1	2	1	2	1	2	2	2	1	1	2	2	1	2
CO4	understand the process in gasification of biomass	2	1	2	1	2	1	2	2	1	1	1	2	2	2	2
CO5	knowledge on the types of combustion of biomass.	2	2	2	2	2	1	2	2	1	1	1	2	2	1	2
Overall CO		2	1	2	1	2	1	2	2	1	1	1	1	2	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3007 **RENEWABLE ENERGY RESOURCES** **L T P C**
3 0 0 3

UNIT I **9**

Introduction: Energy: Past, Today, and Future. A brief history of energy consumption. Energy & Environment. Renewable Energy – Quality, quantity, availability, advantageous and limitations.

UNIT II **9**

Solar energy: Sun and its Energy: Basics of Solar Energy. Solar Energy in the Past. Solar Thermal Energy Solar Photovoltaic.

UNIT III **9**

Bio energy & Geothermal energy: Conversion. Bio degradation. Biogas generation. Fuel properties. Biomass gasifier. Geothermal Resources, Geothermal Technologies.

UNIT IV **9**

Wind energy: Wind Resources. Wind Turbines. Environmental Impact. Data and energy estimation. Conversion. Wind mill Performance and applications.

UNIT V **9**

Tidal energy; Ocean Energy Potential against Wind and Solar. Wave Characteristics and Statistics. Wave Energy Devices. Tide Energy Technologies. Ocean Thermal Energy. Osmotic Power.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on history, consumption of energy
CO2- learn the production of solar energy
CO3- gather knowledge on the geothermal and bio energy
CO4- understand the production of wind energy and their utilization
CO5- knowledge on the production and utilization of tidal energy

TEXT BOOKS

1. Mukherjee, D., and S. Chakrabarti. *Fundamentals of renewable energy systems*. New Age International, 2004.
2. Jenkins, Nicholas, and Janaka Ekanayake. *Renewable energy engineering*. Cambridge University Press, 2017.

REFERENCE BOOKS

1. Kishore, V. V. N., ed. *Renewable energy engineering and technology: principles and practice*. The Energy and Resources Institute (TERI), 2010.
2. Tiwari, Gopal Nath, and Rajeev Kumar Mishra. *Advanced renewable energy sources*. Royal Society of Chemistry, 2012.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the fundamental knowledge on history, consumption of energy	1	1	1	1	1	2	1	2	1	1	1	2	2	2	2
CO2	learn the production of solar energy	1	1	2	2	2	2	1	2	1	1	1	2	2	2	2
CO3	gather knowledge on the geothermal and bio energy	1	2	2	2	2	2	1	1	1	1	1	2	2	2	2
CO4	understand the production of wind energy and their utilization	1	2	2	2	2	2	1	1	1	1	1	2	2	1	1
CO5	knowledge on the production and utilization of tidal energy	1	2	2	2	2	2	1	1	1	1	1	2	2	2	1
Overall CO		1	1	2	2	2	2	1	1	1	1	1	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3008 **PINCH TECHNOLOGY** **L T P C**
3 0 0 3

UNIT I **9**

Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.

UNIT II **9**

Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, continuous targeting.

UNIT III **9**

Pinch Methodology: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram.

UNIT IV **9**

Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, C_P table, heuristics, optimization of heat exchanger network: optimality for a minimum area network.

UNIT V **9**

Energy and Resource Analysis of various processes, Batch process, distillation process, evaporation process, reaction process, process using mass separating agent.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1. Understand the pinch concept and process thermodynamics

CO2. Identify minimum energy targets

CO3. Classify different choices and constraint during heat exchange networking

CO4. Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes

CO5: Analyze the concepts in various chemical processes.

TEXT BOOKS

1. V. Uday Shenoy" Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995.

REFERENCE BOOKS

1. D.W. Linnhoff et al., "User Guide on Process Integration for the efficient use of Energy", Institution of Chemical Engineers, U.K., 1994.
2. James M. Douglas “Conceptual Design of Chemical Process”, McGraw Hill, New York, 1988.
3. Anil Kumar, “Chemical Process Synthesis and Engineering Design”, Tata McGraw Hill New Delhi, 1977.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the pinch concept and process thermodynamics	1	1	1	1	1	2	2	1	2	2	1	1	1	1	2
CO2	Identify minimum energy targets	1	2	1	1	2	2	1	1	2	2	1	1	1	2	2
CO3	Classify different choices and constraint during heat exchange networking	1	2	2	1	3	3	1	1	2	2	1	1	1	2	2
CO4	Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes	1	2	2	1	3	3	2	2	2	2	1	1	1	2	2
CO5	Analyze the concepts in various chemical processes.	1	2	2	2	3	3	2	1	2	2	1	1	1	2	2
Overall CO		1	2	2	1	2	2	2	2	2	2	1	1	1	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3009 HYDROGEN AND FUEL CELL TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To create awareness about alternate clean fuel available. To familiarize the students with the concepts and chemistry of fuel cell

UNIT I INTRODUCTION 9

Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.

UNIT II FUEL CELL KINETICS 9

Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

UNIT III CHARACTERIZATION TECHNIQUES 9

Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.

UNIT IV RENEWABLE SOURCES 9

Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V APPLICATIONS OF FUEL CELL 9

Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications

TOTAL: 45 PERIODS

OUTCOME

On completion of the course, the students will be able to
CO 1: aware of alternate energy sources and its importance of it.
CO2 : understand the fuel cell kinetics
CO3: able to understand the characterization techniques
CO4: Analyze the renewable sources and storage
CO5: Understand the applications of fuel cells in various fields.

TEXTBOOKS

1. Gregor Hoogers, “Fuel Cell Technology Handbook”, CRC Press, 2003.
2. R.P. O'Hayre,S. Cha, W. Colella, F.B. Prinz, “Fuel Cell Fundamentals”, Wiley, 2006.
3. A. J.Bard, L. R. Faulkner, “Electrochemical Methods”, Wiley, 2004.

REFERENCES

1. S. Basu, “Fuel Cell Science and Technology”, Springer, 2007.
2. H. Liu, “Principles of Fuel Cells”, Taylor & Francis, 2006.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	aware of alternate energy sources and its importance of it.	2	1	1	2	1	2	2	2	1	1	1	2	2	2	2
CO2	understand the fuel cell kinetics	2	2	2	3	1	2	2	2	1	2	1	2	2	2	2
CO3	able to understand the characterization techniques	2	2	2	3	3	2	2	2	1	2	1	2	2	2	2
CO4	Analyze the renewable sources and storage	2	2	2	3	3	2	2	2	1	2	2	2	2	2	2
CO5	Understand the applications of fuel cells in various fields.	2	2	2	3	3	2	2	2	1	1	1	2	2	2	2
Overall CO		2	2	2	3	2	2	2	2	1	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3010 **POWER PLANT ENGINEERING** **L T P C**
3 0 0 3

UNIT I **9**

Power Plants - Features, Components and Layouts - Working of Power Plants, Power Plant Economics.

UNIT II **9**

Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers

UNIT III **9**

Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines - Trouble Shooting

UNIT IV **9**

Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles

UNIT V **9**

Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) – Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants.

TOTAL:45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on components, layouts and working of power plants
CO2- learn the types, classification and usage of boilers
CO3- gather knowledge on classification and usage of steam turbines
CO4- understand the types of gas turbines
CO5- knowledge on the application of integration of various process in power plants

TEXT BOOKS

1. Thomas C. Elliott ,"Standard Hand Book of Power Plant Engineering"

REFERENCE BOOKS

1. E L Wakil, "Power Plant Engineering", McGraw-hill Book Co, N.Y. 2001
2.Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003
3. Nag, P.K., "Power Plant Engineering", 2 nd Edition, TMH, 2001

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the fundamental knowledge on components, layouts and working of power plants	2	1	1	2	2	2	2	1	1	1	1	1	2	2	2
CO2	learn the types, classification and usage of boilers	2	2	2	2	2	2	2	2	1	1	2	1	2	2	2
CO3	gather knowledge on classification and usage of steam turbines	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2
CO4	understand the types of gas turbines	2	2	2	2	2	2	2	2	2	1	-	1	2	2	2
CO5	knowledge on the application of integration of various process in power plants	2	2	2	2	2	2	2	3	2	1	1	1	2	2	2
Overall CO		2	2	2	2	2	2	2	2	1	1	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3011 NON-RENEWABLE ENERGY SOURCES L T P C
3 0 0 3

UNIT I 9

Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources.

UNIT II 9

Types of coal; Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal.

UNIT III NATURAL GAS 9

Resources of for Natural Gas, Properties and classification of natural gas, transporation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal.

UNIT IV NUCLEAR ENGINEERING FUNDAMENTALS 9

Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Nuclear Fuels; Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium.

UNIT V NUCLEAR ENERGY 9

Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant -Waste Management and Safety

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on petroleum and its products
CO2- learn the usage of coal, types and its composition
CO3- gather knowledge on the properties, classification and products of natural gas
CO4- understand the fundamentals of nuclear engineering
CO5- knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.

TEXT BOOKS

1. Breeze, Paul. Nuclear power. Academic Press, 2016.
2. Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversion processes and applications. Newnes, 2016.
3. Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable and Conventional. " Khanna Publication, 3rd (2012).

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the fundamental knowledge on petroleum and its products	1	2	2	1	1	1	1	2	1	2	-	1	2	2	2
CO2	learn the usage of coal, types and its composition	2	2	2	1	1	1	1	2	1	2	-	1	2	2	2
CO3	gather knowledge on the properties, classification and products of natural gas	2	2	2	1	1	1	1	2	1	2	1	2	2	2	2
CO4	understand the fundamentals of nuclear engineering	2	2	2	1	1	1	1	2	1	2	1	2	2	2	2
CO5	knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.	2	2	2	1	1	1	1	2	1	2	3	3	2	2	2
Overall CO		2	2	2	1	1	1	1	2	1	2	1	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PEC- Biochemical Engineering

BT3392 BIOCHEMISTRY L T P C
3 0 0 3

OBJECTIVE

To enable students learn the fundamentals of Biochemical Processes and Biomolecules

UNIT I INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES: 9

Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate

UNIT II STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES 9

Structure and properties of Important Biomolecules.

Lipids: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins.

Protein: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.

Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

UNIT III METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM 9

Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt.

UNIT IV INTERMEDIARY METABOLISM AND REGULATION 9

Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

UNIT V PROTEIN TRANSPORT AND DEGRADATION 9

Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course, the students will be able to

- CO1 – understand the basic concepts on carbohydrates.
- CO2 – learn the concepts of proteins
- CO3 – gather knowledge on importance of nucleic acids
- CO4 – understand the knowledge on lipids
- CO5 – gather knowledge on intermediary metabolism and their pathways

TEXT BOOKS

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, “Biochemistry” 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. “Biochemistry” 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., etal., “Outlines of Biochemistry” 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

REFERENCES

1. Berg, Jeremy M. et al. “Biochemsitry”, 6^{th} Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., etal “Harper’s Illustrated Biochemistry”, 31^{st} Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., “Biochemistry”, 4th Edition, John Wiley & Sons Inc.,2010.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic concepts on carbohydrates.	2	-	-	-	-	1	2	1	2	2	1	1	2	2	2
CO2	learn the concepts of proteins	2	-	-	-	-	1	2	1	2	2	1	1	2	2	2
CO3	gather knowledge on importance of nucleic acids	2	-	-	1	1	1	2	1	2	2	1	1	2	2	2
CO4	understand the knowledge on lipids	2	-	-	1	1	1	2	1	2	2	1	1	2	2	2
CO5	gather knowledge on intermediary metabolism and their pathways	2	1	1	1	2	1	2	1	2	2	2	2	2	2	2
Overall CO		2	1	1	1	1	1	2	1	2	2	1	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3012 **BIOPROCESS TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of bioprocesses
- To understand the production process of biomolecules
- To have a strong foundation in bioreactors.

UNIT I INTRODUCTION TO BIOPROCESS 9

Biologists and Engineers, comparison of chemical and biochemical processing overview of biological basics, About cells and its growth, the stoichiometry of microbial growth and product Bioprocesses: Regulatory Constraints

UNIT II MEDIA FORMULATION AND DEVELOPMENT 9

Media formulation, Media Sterilization: Methods of heat sterilization of media, thermal death kinetics, design criteria, batch and continuous sterilization. Air Sterilization: Methods of air sterilization, mechanism of air sterilization, solid and liquid handling. Industrially fermented broth

UNIT III UNDERSTANDING BIOREACTORS 9

Purpose and importance of bioreactors, Classification of bioreactors, bioreactors for animal cells, bioreactors for plant cells, bioreactors for immobilized cells, operations of bioreactors, stirred tank reactor, plug flow reactor (PFR), fluidized bed reactor, bubble column, airlift reactor, Agitation, and Aeration: Mechanical agitation, power consumption in agitation, bubble aeration, bioreactors for waste management

UNIT IV TRANSPORT PROCESSES 9

Aspects of rheology, Fluid flow in packed-bed and Fluidized bed columns, Gas-liquid mass transfer in cellular systems Diffusivity and mechanism of mass transfer - derivation of the equations of mass transport by diffusion-stationary and unsteady mass transport by diffusion, mass transfer coefficient, macroscopic balances for mass transport. Mechanisms and applications of heat transfer-mode of heat transfer-conduction, convection and radiation, Application of Heat and Mass transfer in biochemical processes.

UNIT V BIOETHICS AND BIOSAFETY 9

Introduction to Bioethics. Social and ethical issues, the process of biotechnology involved in generating new forms of life for informed decision making, Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release into the environment.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on bioprocess technology
CO2- learn the the production process of biomolecules
CO3- gather knowledge on the operations of bioreactors and their purposes
CO4- understand the transportation processes in reactors and their behaviors
CO5- knowledge on the biosafety and information on bioethics.

TEXT BOOKS:

1. Bailey, J. E., and D. F. Ollis. Biochemical Engineering Fundamentals. 2nd ed. New York, McGraw-Hill, 1986.
2. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel, Dekker Inc., 1996.
3. Pauline M. Doran. Bioprocess Engineering Principles. 2nd ed. Elsevier Science & Technology Books. 1995

REFERENCES

1. Transport Phenomena, by Bird R.B., Steward W.E., and Lightfoot E.N., John Wiley & sons, Inc., New York, 2002
2. C J Geankoplis, Transport Processes and Separation Processes Principles, 4th Edition, New Jersey, PHI Publishers, 2010

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the fundamental knowledge on bioprocess technology	2	1	1	2	1	1	2	2	1	1	1	2	2	2	2
CO2	learn the the production process of biomolecules	2	2	2	2	1	1	2	2	2	1	1	2	2	2	2
CO3	gather knowledge on the operations of bioreactors and their purposes	2	3	3	2	2	1	2	2	2	1	1	2	2	2	2
CO4	understand the transportation processes in reactors and their behaviors	2	3	3	2	2	1	2	2	2	1	2	2	2	2	2
CO5	knowledge on the biosafety and information on bioethics.	2	1	1	2	2	1	2	3	3	2	2	2	2	2	2
Overall CO		2	2	2	2	2	1	2	2	2	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3013 FERMENTATION AND BIOPROCESSING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand fermentation and its kinetics
- To understand structural, functional properties of microbes
- To design fermenter with auxiliaries

UNIT I FERMENTATION PROCESSES 9

Importance of fermentation, Fermentation and redox potential, solid-liquid fermentation, solid state fermentation, Kinetics of fermentations, Biosensors for fermentations, Production processes in fermentation.

UNIT II MICROBIAL GROWTH KINETICS 9

Diversity of patterns of microbial growth in situ and ex situ, Microbial growth under homogeneous conditions, Heterogeneous microbial growth, Growth kinetics, Derivation of mathematical models, and identification

UNIT III DESIGN OF FERMENTERS 9

fermentation processes, Fermentation processes and microorganisms**, Kinetics and stoichiometry, Mass balances and design for batch, continuous and fed-batch reactors,** Comparison of batch, continuous and fed-batch reactors, **Heat generation and heat balances, examples of industrial fermentation processes**

UNIT IV INSTRUMENTATION AND CONTROL 9

Common Instruments for Process Automation – Temperature, Gas Flowrate, Liquid Flowrate, Off-Gas Analysis, pH, Dissolved Oxygen, Pressure, Foam Level, Stirring , Redox Potential, Advanced Instrumentation for Bioprocess Control and Automation - Flow Injection Analysis, Sequential Injection Analysis Fluorescence, Mass Spectrometry, Near Infrared Spectroscopy, Soft sensors, Biomass, Bioreactor automation

UNIT V FERMENTATION AND COMMODITY PRODUCTS 9

Engineering of Secretory Pathways, production of heterologous proteins, fungal, yeast fermentation of industrial products.

TOTAL : 45PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1- understand the structural, functional properties of microbes

CO2- learn the growth kinetics of microorganisms

CO3- understand the basic concepts in designing of fermenters

CO4- gather knowledge on the operation of control systems in fermentation and bioprocess industry

CO5- acquire knowledge on the commodity, fermentation production and their production pathways

TEXTBOOKS:

1. Essentials in Fermentation Technology, Aydin Berenjian, Springer ,2019.
2. Principles of Fermentation Technology (Second Edition), Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Pergamon, 1995

REFERENCES:

1. Fermentation and Biochemical Engineering Handbook; Editors-in-Chief: Henry C. Vogel and Celeste M. Todaro, Third Edition, Elsevier, 2014.
2. Fermentation Biotechnology: Principles, Processes, and Products (Prentice Hall advanced references series), Owen P. Ward, Prentice Hall, 1989

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the structural, functional properties of microbes	1	1	1	1	1	2	2	2	2	1	1	2	1	-	-
CO2	learn the growth kinetics of microorganisms	1	2	1	2	2	2	2	2	2	1	1	2	1	2	1
CO3	understand the basic concepts in designing of fermenters	1	2	3	3	3	2	2	2	2	1	2	2	1	2	1
CO4	gather knowledge on the operation of control systems in fermentation and bioprocess industry	1	2	3	3	3	2	2	2	2	2	2	2	1	2	1
CO5	acquire knowledge on the commodity, fermentation production and their production pathways	1	2	2	2	3	2	2	2	2	2	2	2	1	2	1
Overall CO		1	2	2	2	2	2	2	2	2	1	2	2	1	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3014 BIOSEPARATION AND DOWNSTREAM PROCESSING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the fundamentals of bio separations
- To design unit operations steps for various downstream purification steps
- To gain knowledge on theory, design, and application of bioprocessing.

UNIT I INTRODUCTION 9

Introduction to By-products and Bioseparation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of the physical, chemical and biochemical aspects of biomolecules. Stages of Downstream Processing

UNIT II CENTRIFUGATION AND FILTRATION 9

Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes

UNIT III ABSORPTION 9

Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co- current, Countercurrent, Multistage Counter current Operation, Absorption with Chemical Reactions, Related problems

UNIT IV EXTRACTION 9

Liquid-Liquid Separation Process: Single Stage Operation, Equipments for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, solid-liquid extraction, Supercritical fluid Extraction. Different types of extractors and designing of extractors. Distillation: Simple, Steam and Equilibrium distillation, Fractionation, Mccabe Thiele method, azotropes,

UNIT V CHROMATOGRAPHY AND MEMBRANE SEPARATION 9

Theory of chromatography, Shape and yield of a chromatographic peak, Binary chromatography, Hydrodynamic chromatography. Membrane-based bioseparation - Classification of membrane processes, Ultrafiltration, Microfiltration, Dialysis, Liquid membrane processes, Membrane chromatography, Electrophoresis, Affinity ultrafiltration, Field-flow fractionation

TOTAL :45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1- understand the basic concept of bioseparation processes
CO2- acquire knowledge on theory, design, and application of bioprocessing
CO3- to understand the basic concepts absorption and their problems in bioprocessing
CO4- gather knowledge on extraction of bioproducts using different methods
CO5- acquire knowledge on chromatography techniques and their analysis, membrane separation process

TEST BOOKS:

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press
3. B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
4. Bioseparation & bioprocessing (2nd Ed) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)

REFERENCES:

1. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
2. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.
   Scopes Ak, Protein Purification, IRL Press, 1993
3. Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993
4. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989
5. T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances in Biochemical Engineering /Biotechnology, Vol 56) by Springer Verlag

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic concept of bioseparation processes	2	1	1	1	1	1	2	2	2	2	2	2	2	1	2
CO2	acquire knowledge on theory, design, and application of bioprocessing	2	2	2	2	3	1	2	2	2	2	2	2	2	2	2
CO3	to understand the basic concepts absorption and their problems in bioprocessing	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO4	gather knowledge on extraction of bioproducts using different methods	2	2	2	2	3	2	2	2	2	1	2	2	2	2	2
CO5	acquire knowledge on chromatography techniques and their analysis, membrane separation process	2	3	2	3	3	2	2	2	2	1	2	2	2	2	2
Overall CO		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3015 ENZYME IMMOBILISATION TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:
- To understand Enzymes, homogeneity, and heterogenicity
- To understand structural, functional properties, and metabolic pathways
- To learn immobilization procedures, and types.
- To design enzyme reactors

UNIT I INTRODUCTION 9
Catalysis and biocatalysis, Enzyme classification and nomenclature, enzyme structure, functionality and relationship, enzyme activity, enzyme sources, synthesis, recovery and purification, enzymes as process catalysts.

UNIT II HOMOGENEOUS ENZYME KINETICS 9
Hypothesis of enzyme kinetics, rapid equilibrium and steady-state hypothesis, determination of kinetic parameters, various types of kinetic inhibition, reactions with more than one substrate, effect of environmental variables- pH, temperature, and ionic strength.

UNIT III BASICS OF IMMOBILISATION 9
Immobilisation – Functional properties, Classification of Immobilisation techniques – Adsorption, matrix entrapment, crosslinking, covalent binding- advantages & disadvantages of each method, selection and characterisation of matrices for immobilisation, effect of physico chemical parameters on immobilised enzymes.

UNIT IV HETEROGENEOUS ENZYME KINETICS 9
Mass transfer effects in heterogeneous biocatalysis, partition effects, Immobilised enzyme kinetics - external (film) diffusion, internal (pore) diffusional kinetics, Thiele modulus and Effectiveness factor. Effects of electrostatic potential of the micro environment.

UNIT V ENZYME REACTORS & APPLICATION OF IMMOBILISED ENZYMES 9
Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems, Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products, as biosensors.

TOTAL :45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1 – understand the basic knowledge on classification of enzymes and their nomenclature
CO2 - understand Enzymes, homogeneity, and heterogenicity
CO3 - understand structural, functional properties, and metabolic pathways of enzymes
CO4 - learn immobilization procedures, and their different types.
CO5 – knowledge on designing enzyme reactors.

TEXT BOOKS:

1. “Enzyme Technology” by M.F.Chaplin and C.Bucke, Cambridge University press, 1990. (Website for the book, www:lsbu.ac.uk/biology/enztech/)
2. “Biocatalysts and Enzyme Technology” by K. Buchholz,V. Kasche and U.T. Bornscheur, Wiley,2005

REFERENCE BOOKS:

1. “Enzyme Technology”, by Shanmugam,S. and Satish Kumar,T.,IK International Pvt. Ltd, New Delhi, 2008
3. Enzyme Biocatalysis: Principles and Applications’ by A.Illanes, Springer,2008

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic knowledge on classification of enzymes and their nomenclature	2	-	-	1	-	1	1	2	1	1	-	1	2	1	1
CO2	understand Enzymes, homogeneity, and heterogenicity	2	-	1	1	1	1	1	2	1	1	-	1	2	1	1
CO3	understand structural, functional properties, and metabolic pathways of enzymes	2	-	1	1	1	1	1	2	1	1	-	1	2	1	1
CO4	learn immobilization procedures, and their different types.	2	2	2	1	2	1	1	2	1	1	-	1	2	1	1
CO5	knowledge on designing enzyme reactors.	2	2	3	2	2	2	1	2	2	1	2	1	2	1	1
Overall CO		2	1	2	1	1	1	1	2	1	1	1	1	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3016 **BIOREACTOR DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of bioreactor design
- To design single and multiple bioreactors
- To design a bioprocess system.

UNIT I BIOREACTOR DESIGN & MEDIA REQUIREMENTS 9

Microbial growth and product formation kinetics, Bioreactor Selection, Reactor operational mode and selection.

UNIT II DESIGN EQUATIONS FOR BIOREACTORS 9

Basic Design Equations/ Mole Balances: Batch, Fed-Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors, Microbial death kinetics, Design criterion for sterilization, Batch and continuous sterilization of medium, Multiple reactions-series, parallel and mixed-mode, Air sterilization

Unit III BIOREACTOR REQUIREMENTS 9

Process-General requirements; Basic design and construction of bioreactors and their ancillaries; Material of construction, Vessel geometry, Bearing Assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors, Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression

UNIT IV DESIGN OF BIOREACTORS 9

Process and mechanical design of Bioreactors, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system, scale-up, scale down, bioinstrumentation and control.

UNIT V NOVEL BIOREACTORS DESIGN 9

Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Airlift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; SSF bioreactors. bioreactor design considerations for plant and animal cell cultures.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate.

CO2: Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors

CO3:Helps to understand various requirements such as material of construction, valves, agitator, sensors etc

CO4:Understanding the mechanical design and heat transfer calculations for various type of bioreactor

CO5: Analyze immobilization techniques in reactors and use it for various applications

TEXT BOOKS:

1. Bioprocess Engineering -Kinetics, Mass Transport, Reactors and Gene Expression Wolf R. Vieth A Wiley-Interscience Publication 1994
2. Chemical Kinetic Methods: Principles of relaxation techniques Kalidas C New Age International 1996
3. Chemical Reactor Analysis and Design Forment G F and Bischoff K B John Wiley 1990

REFERENCE:

- Bioprocess Engineering -Kinetics, Biosystems, sustainability and reactor Design, Shijie Liu, Elsevier Publication 2013.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate	1	2	2	3	3	2	2	2	2	2	2	2	2	2	2
CO2	Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2
CO3	Helps to understand various requirements such as material of construction,valves,agitator,sensors etc	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2
CO4	Understanding the mechanical design and heat transfer calculations for various type of bioreactor	2	2	3	3	3	2	2	2	3	2	2	2	2	3	2
CO5	Analyze immobilization techniques in reactors and use it for various applications	2	2	3	3	3	2	2	2	3	2	2	3	2	3	2
Overall CO		2	2	2	3	3	2	2	2	3	2	2	2	2	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PEC- Environmental and safety engineering

CH3017 AIR POLLUTION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

• To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality.

UNIT I INTRODUCTION 9

Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties of Air Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index

UNIT II GASEOUS POLLUTANTS 9

Absorption- Principles, Description of equipment-Packed and Plate columns -Design and Performance equations; .Adsorption- Principle Adsorbents, Equipment descriptions - PSA - Adsorption cycle - Solvent recovery system-Continuous Rotary bed, Fluidized bed, Design and Performance equations ; Incinerators, Hydrocarbon incineration kinetics- Equipment description- Design and Performance equations.

UNIT III PARTICULATE AIR POLLUTION 9

Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficiency – Gravity Settling chambers Cyclones- Electrostatic precipitators and Bag houses

UNIT IV AIR POLLUTION CONTROL 9

Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristics and control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters – Techniques of air pollution control - equipments

UNIT V AIR POLLUTION MODELLING 9

Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to

CO1 Understand the nature and characteristics of air pollutants, and basic concepts of air quality management.

CO2: Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards

CO3: Understand the knowledge about particulate air pollutants and control devices.

CO4: Relate the air quality behaviour and its measurement

CO5: Control the air pollution in industries using various models.

TEXT BOOKS:

1. Richardw.Boubeletal.,“FundamentalsofAirPollution”,AcademicPress,NewYork,1994.
2. .NoelDeNevers,“AirPollutionControlEngg.”,McGrawHill,NewYork,1995.
3. M.N.Raoetal.,“AirPollution”TataMcGrawHill,1989.

REFERENCE BOOKS

1. David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.
2. Stern, A.C., Air Pollution (Vol.I – Vol.VIII), Academic Press, 2006.
4. Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons,Inc.,2000.
5. Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2012
6. Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4th edn, 1997.

7. Nevers, N., Air Pollution Control Engineering, McGraw Hill, New York, 2011.
8. Anjaneyulu, Y., Air Pollution and Control Technologies, Allied Publishers (P) Ltd., India, 2002.
9. Wang, L.K., Parelra, N.C., Hung, Y.T., Air Pollution Control Engineering, Tokyo, 2004.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the nature and characteristics of air pollutants, and basic concepts of air quality management	2	1	1	2	1	2	2	2	2	2	2	2	2	1	2
CO2	Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2
CO3	Understand the knowledge about particulate air pollutants and control devices.	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2
CO4	Relate the air quality behaviour and its measurement	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2
CO5	Control the air pollution in industries using various models.	2	3	3	2	3	2	2	2	2	2	2	1	2	2	2
Overall CO		2	2	2	2	2	2	2	2	2	2	2	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3018 **WASTE WATER TREATMENT** **L T P C**
3 0 0 3

OBJECTIVE:

• To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

UNIT I WASTE WATER TREATMENT AN OVERVIEW 9

Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents.

UNIT II CHEMICAL UNIT PROCESSES 9

Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization –disinfection

UNIT III BIOLOGICAL TREATMENT 9

Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type.

UNIT IV TREATMENT METHODS 9

Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal

UNIT V ADVANCED WASTE WATER TREATMENT 9

Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge. - Software Applications

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to
CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement.
CO2: Understand the various pollutant treatment techniques.
CO3: Understand the concepts using biological treatment methods
CO4: Analyze the reactors used for various treatment techniques
CO5: Understand the membrane based electrochemical process for pollutant treatment.

TEXT BOOKS:

1. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
3. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
4. 4 .C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007

REFERENCE BOOKS

1. Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006.
2. Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw-Hill, 1995. 14
3. Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2002.
4. Sincero, P.A., and Sincero, A.G., Physical Chemical treatment of water and wastewater, IWA Publications, 2002.
5. Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009.

CO's, PO's & PSO's MAPPING

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the Physical and chemical Characteristics of wastewater and their measurement.	2	-	1	2	2	2	2	2	2	2	2	2	2	1	1
CO2	Understand the various pollutant treatment techniques.	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1
CO3	Understand the concepts using biological treatment methods	2	2	2	2	3	2	2	2	2	2	2	2	2	2	1
CO4	Analyze the reactors used for various treatment techniques	2	2	2	2	3	2	2	2	2	2	2	2	2	2	1
CO5	Understand the membrane based electrochemical process for pollutant treatment.	2	3	2	2	3	2	2	2	2	2	2	2	2	2	1
Overall CO		2	2	2	2	3	2	2	2	2	2	2	2	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3019 SOLID WASTE MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:
• To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT I SOURCES AND CHARACTERISTICS 9
Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) –- Role of public and NGO‟s- Public Private participation – Elements of Municipal Solid Waste Management Plan.

UNIT II SOURCE REDUCTION, WASTE STORAGE AND RECYCLING 9
Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes.

UNIT III COLLECTION AND TRANSFER OF WASTES 9
Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.

UNIT IV PROCESSING OF WASTES 9
Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.

UNIT V WASTE DISPOSAL 9
Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – Dumpsite Rehabilitation

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1: State solid waste characteristics and its sources.
CO2: Identify and analyze different methods of treatment of solid waste.
CO3: Illustrate Industrial practices in solid waste management.
CO4: Discuss the significance of recycling reuse and reclamation of solid wastes.
CO5: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

TEXTBOOKS:

1. William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
2. John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.
3. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. “Solid. Wastes: Engineering Principles and Management Issues”. McGraw Hill, New York, 1993.
4. Vesilind, P.A. and Rimer, A.E., “Unit Operations in Resource Recovery Engineering”, Prentice Hall, Inc., 1981

REFERENCE BOOKS:

1. Government of India, “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of UrbanDevelopment, New Delhi, 2000.
2. Manser A.G.R. and Keeling A.A.,” Practical Handbook of Processing and Recycling of Municipal solid Wastes”, Lewis Publishers, CRC Press, 1996.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	State solid waste characteristics and its sources.	2	-	-	-	-	1	2	2	2	2	1	2	2	1	2
CO2	Identify and analyze different methods of treatment of solid waste.	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2
CO3	Illustrate Industrial practices in solid waste management.	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2
CO4	Discuss the significance of recycling reuse and reclamation of solid wastes.	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2
Overall CO		2	1	2	2	2	2	2	2	2	2	2	2	1	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3020 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

• To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

UNIT I INTRODUCTION 9

Impacts of Development on Environment – Rio Principles of Sustainable Development-Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

UNIT II ENVIRONMENTAL ASSESSMENT 9

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance

UNIT IV SOCIO ECONOMIC ASSESSMENT 9

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis

UNIT V MONITORING STUDIES AND APPLICATIONS 9

Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit ; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:Understand the concept of environmental Impact assessment

CO2: Know various components and assessment techniques of EIA.

CO3:Understand Environmental management plan

CO4: Understand socio economic assessment plans

CO5: gain knowledge about EIA monitoring studies through various industrial exposure

TEXT BOOKS:

1. Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 1996.
2. Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 2009.
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
4. Anjaneyulu, Y., and Manickam, V., Environmental Impact Assessment, Methodologies, 2nd Edition, BS Publications, 2007

REFERENCE BOOKS:

1. Becker H. A., Frank Vanclay, “The International handbook of social impact assessment” conceptual and methodological advances, Edward Elgar Publishing,2003.
2. Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme,2002.
3. Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

5. Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
6. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
7. Morris, P., and Therivel, R., Methods of Environmental Impact Assessment, 3rd Edition, Taylor & Francis, 2009.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the concept of environmental Impact assessment	2	1	1	2	1	2	2	2	2	2	2	2	2	2	2
CO2	Know various components and assessment techniques of EIA.	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO3	Understand Environmental management plan	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO4	Understand socio economic assessment plans	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO5	gain knowledge about EIA monitoring studies through various industrial exposure	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
Overall CO		2	1	1	2	1	2	2	2	2	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3021 PROCESS SAFETY MANAGEMENT L T P C
3 0 0 3

UNIT I PROCESS SAFETY INFORMATION 9

Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) – Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges

UNIT II SAFETY PROGRAMMES AND PROCEDURES 9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning

UNIT III ACCIDENT ANALYSIS 9

Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations ; Past accident analysis-Fixborough-Mexico- Chernobyl nuclear disaster-Bhopal gas analysis- process safety indicators

UNIT IV PROCESS HAZARD ANALYSIS 9

Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V SAFETY MANAGEMENT 9

Employee Participation – Overview, Benefits of Employee participation, Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes-Institutionalizing and integrating safety into the PSM fabric, 5 tier approach, selection, training, Performance monitoring; Case studies – Process safety management in industry – present and futuristic approach.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1 - Understand the chemical process safety, safety codes
CO2 – safe handling of chemicals and plant inspection
CO3 – learn the different analysis to overcome the accidents in process industry
CO4 – understand the hazard analysis in process industry
CO5 – knowledge on safety management in different process industry

TEXT BOOKS:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., “Safety and Accident Prevention in Chemical Operation“, Wiley Interscience, 1965.
3. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004

REFERENCE BOOKS:

1. Handley, W., “Industrial Safety Hand Book “, 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., “Industrial Accident Prevention“, McGrawHill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the chemical process safety, safety codes	2	-	-	-	-	2	2	2	2	2	1	2	2	2	1
CO2	safe handling of chemicals and plant inspection	2	-	2	2	-	2	2	2	2	2	1	2	2	2	2
CO3	learn the different analysis to overcome the accidents in process industry	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	understand the hazard analysis in process industry	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO5	knowledge on safety management in different process industry	2	2	3	2	3	2	2	2	2	2	2	2	2	2	2
Overall CO		2	1	1	1	2	2	2	2	2	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3022 RISK AND HAZOP ANALYSIS L T P C
3 0 0 3

UNIT I RISK ANALYSIS 9

Risk analysis introduction, quantitative risk assessment, rapid risk analysis –comprehensive risk analysis – identification, evaluation and control of risk

UNIT II RISK ASSESSMENT 9

Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis -

UNIT III EMERGENCY PLANNING 9

Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies- marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV HAZARD 9

Hazard - Hazard identification – methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V HAZOP 9

Introduction to HAZOP-Significance of HAZOP -HAZOP procedure –HAZOP Analysis -Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the knowledge of types of risks arising in working environment

CO2: Perform Risk Assurance and Assessment

CO3: Design Risk management systems and planning

CO4: Analyze the effect of process hazard

CO5: hazop and its consequences and to create hazard free working premises

TEXT BOOKS:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., “Safety and Accident Prevention in Chemical Operation“, Wiley Interscience, 1965.
3. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004

REFERENCES:

1. Handley, W., “Industrial Safety Hand Book “, 2nd Edition. McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., “Industrial Accident Prevention“, McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the knowledge of types of risks arising in working environment	2	-	-	-	-	2	2	2	2	1	1	1	2	-	1
CO2	Perform Risk Assurance and Assessment	2	1	2	2	2	2	2	2	2	1	2	1	2	-	1
CO3	Design Risk management systems and planning	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
CO4	Analyze the effect of process hazard	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
CO5	hazop and its consequences and to create hazard free working premises	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
	Overall CO	2	2	2	2	2	2	2	2	2	1	2	2	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PEC- Computational Chemical Engineering

CH3023 COMPUTATIONAL TECHNIQUES L T P C
3 0 0 3

UNIT I NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAIC EQUATIONS 9

Gauss elimination, LU decomposition, matrix inversion, Tri-diagonal matrix algorithm, Gauss-Seidel method, Chemical Engineering problems involving solution of linear algebraic equations.

UNIT II NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS 9

Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations

UNIT III INTERPOLATION AND NUMERICAL INTEGRATION 9

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

UNIT IV NUMERICAL METHODS FOR ODES 9

Euler method – explicit and implicit, Runge-Kutta method – 2nd and 4th order, Boundary value problems – shooting method, Chemical engineering problems involving single and system of ODEs.

UNIT V NUMERICAL METHODS FOR PDES 9

Introduction to Partial Differential Equations: Characterization of PDEs, parabolic, elliptic and first order hyperbolic equations, explicit and implicit methods, Chemical engineering problems involving the three types of PDEs.

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course, the students will be able to
CO1 - Understand the numerical methods for linear algebraic equations.
CO2 – Identify numerical methods for non linear algebraic equations
CO3 - Identify different methods for interpolation and numerical integration
CO4 – knowledge on the numerical methods for ordinary differential equations
CO5 – understand the basic methods for partial differential equations

TEXT BOOKS

1. Chapra. S. C. & Canale, R. P., "Numerical Methods for Engineers", Eighth Edition, McGraw Hill, 2021.
2. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
3. Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCE BOOKS

1. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the numerical methods for linear algebraic equations	2	2	1	2	1	1	-	-	1	2	2	2	2	2	1
CO2	Identify numerical methods for nonlinear algebraic equations	2	2	1	2	1	1	-	-	1	2	2	2	2	2	-
CO3	Identify different methods for interpolation and numerical integration	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
CO4	knowledge on the numerical methods for ordinary differential equations	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
CO5	understand the basic methods for partial differential equations	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
Overall CO		2	2	1	2	1	1	1	-	1	2	2	2	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3024 OPTIMIZATION OF CHEMICAL PROCESSES **L T P C**
3 0 0 3

UNIT I PROBLEM FORMULATION & CLASSIFCATION 9

Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods

UNIT II LINEAR PROGRAMMING 9

Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming.

UNIT III NON-LINEAR PROGRAMMING 9

The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming.

UNIT IV NUMERICAL METHODS 9

Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant method

UNIT V APPLICATIONS 9

Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1: be familiar on the basic problem formulation and optimization.
CO2:Understand mathematical characteristics of Linear programming
CO3:Learn computational solution techniques for nonlinear unconstrained optimization.
CO4:Understand various techniques used in constrained optimization
CO5:Apply the optimal and dynamic optimization.

TEXT BOOKS

1. Edgar T.F., Himmelblau D.M., Lasdon,L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill, New York, 2001.
2. Rao, S. S., Engineering Optimization: Theory and Practice, Fifth Edition, Wiley, New York, 2019.

REFERENCE BOOKS

1. Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	be familiar on the basic problem formulation and optimization.	1	2	2	2	2	1	1	-	1	1	1	2	2	2	2
CO2	Understand mathematical characteristics of Linear programming	1	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO3	Learn computational solution techniques for nonlinear unconstrained optimization	1	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO4	Understand various techniques used in constrained optimization	2	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO5	Apply the optimal and dynamic optimization	2	2	2	2	2	1	1	-	1	2	2	2	2	2	2
Overall CO		1	2	2	2	2	1	1	-	1	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CCH331 PROCESS MODELING AND SIMULATION L T P C
3 0 0 3

UNIT I INTRODUCTION AND FIRST PRINCIPLES 9

Definition, Uses of Mathematical Models - Principles of formulation, Classification of Process Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation – Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples.

UNIT II LUMPED SYSTEMS 9

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system.

UNIT III STAGED OPERATIONS AND DISTRIBUTED SYSTEMS 9

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators.

UNIT IV FITTING MODEL TO DATA 9

Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R^2)

UNIT V SIMULATION OF BASIC MODELS 9

MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler’s explicit and implicit techniques, Introduction to ODE 45 solver, Dynamic simulation of simple tank, variable flow tank, enclosed tank with isothermal compression, mixing vessel, mixing vessel with reaction using ODE 45 solver.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics

CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods

CO3: Create the mathematical models for different unit operations equipments

CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems

CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions

TEXT BOOKS

1. Bequette, B. W., Process Dynamics: Modeling, Analysis, and Simulation. Prentice-Hall, 2002.
2. Babu, B V., Process Plant Simulation, Oxford University Press, 2004
3. Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCE BOOKS

1. Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.
2. Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

CO's, PO's & PSO's MAPPING

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics	2	2	2	2	1	1	1	1	2	1	1	2	2	2	1
CO2	Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO3	Create the mathematical models for different unit operations equipments	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO4	Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO5	Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
Overall CO		2	2	2	2	2	1	1	1	2	1	1	2	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3025 PINCH ANALYSIS AND HEAT EXCHANGER NETWORK DESIGN **L T P C**
3 0 0 3

UNIT I INTRODUCTION 9

Pinch analysis, process synthesis, pinch point, composite curves, energy targeting: problem table algorithm, shifted composite curve, capital cost, total cost targeting, process modification.

UNIT II TARGETING 9

Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.

UNIT III PINCH ANALYSIS 9

Identification of streams, temperature, enthalpy diagram, minimum temperature difference, construction of composite curves, energy cost target, optimum target, design of heat exchanger network.

UNIT IV PINCH DESIGN AND OPTIMIZATION 9

Networks for maximum energy recovery, Pinch design method, flexibility criteria of the pinch, optimization of heat exchanger network, optimality for a minimum area network, Sensitivity analysis.

UNIT V ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES 9

Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent, heat pipes and heat pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1. Understand the pinch concept and process thermodynamics

CO2. Identify minimum energy targets

CO3: Understand the knowledge of diagrams and energy cost target

CO4. Identify different choices and constraint during heat exchange networking

CO5. Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes

TEXT BOOKS

1. Kemp, I. C., Pinch Analysis and Process Integration, Second edition, Elsevier, 2006.
2. Shenoy, V. U., Heat Exchanger network synthesis, Gulf Publishing, 1995.

REFERENCE BOOKS

1. Douglas, J. M., Conceptual Design of Chemical Process, McGraw Hill, 1988.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the pinch concept and process thermodynamics	2	1	1	2	2	1	2	2	2	2	1	2	2	1	2
CO2	Identify minimum energy targets	2	1	2	2	2	1	2	2	2	2	1	2	2	2	2
CO3	Understand the knowledge of diagrams and energy cost target	2	1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO4	Identify different choices and constraint during heat exchange networking	2	1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO5	Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes	2	2	3	2	2	1	2	2	2	2	2	2	2	1	2
Overall CO		2	1	2	2	2	1	2	2	2	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3026 CHEMICAL PROCESS FLOW SHEETING L T P C
3 0 0 3

UNIT I FLOWSHEETING 6

Introduction, symbols, flowsheet presentation with examples, manual flowsheet calculation, flowsheeting approaches.

UNIT II DECOMPOSITION OF NETWORKS 11

Partitioning and tearing a flowsheet, tearing algorithms based on signal flow graph, algorithms based on reduced graph, comparing various tearing algorithms

UNIT III SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING 11

Principle of method, convergence of flowsheet using different methods - Newton's method, direct substitution, Wegstein's method, dominant Eigenvalue method, quasi Newton method, criteria for acceleration

UNIT IV FLOWSHEETING BY EQUATION SOLVING METHODS 9

Precedence ordering, disjoining, tearing a system of equations, SWS algorithm, maintaining sparsity, solution of system of equations using Newton's method

UNIT V CASE STUDIES 8

Simulation of process flowsheets involving mass recycle, energy recycle, tear stream and design specification, demonstration of open source flowsheeting software.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – understand the basic concept in preparation of flowsheet
CO2 – knowledge on preparing networks
CO3 – understand different approach in flowsheeting
CO4 – to learn the flowsheet preparation by equation solving methods
CO5 – Evaluate the case studies using flowsheeting software.

TEXT BOOKS

1. Babu, B V., Process Plant Simulation, Oxford University Press, 2004

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic concept in preparation of flowsheet	2	-	-	-	1	-	1	1	1	2	1	2	2	2	2
CO2	knowledge on preparing networks	2	-	-	-	2	1	1	1	1	2	1	2	2	2	2
CO3	understand different approach in flowsheeting	2	1	2	1	2	1	1	1	1	2	2	2	2	2	2
CO4	to learn the flowsheet preparation by equation solving methods	2	2	2	1	2	1	1	1	1	2	2	2	2	2	2
CO5	Evaluate the case studies using flowsheeting software	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
Overall CO		2	1	1	1	2	1	1	1	1	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3027 COMPUTATIONAL FLUID DYNAMICS **L T P C**
3 0 0 3

UNIT I GOVERNING EQUATIONS 9

Governing equations of fluid flow and heat transfer - Navier-Stokes equations for a Newtonian fluid, Classification of physical behaviour, Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations.

UNIT II TURBULENCE AND ITS MODELLING 9

Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, free turbulent flows, flat plate boundary layer and pipe flow, Turbulence models, mixing length model, The k-omega model, Reynolds stress equation model, algebraic stress equation model.

UNIT III FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS 9

Introduction to finite volume method, one-dimensional steady state diffusion, two-dimensional diffusion, discretised equations for diffusion problems.

UNIT IV FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS 9

Steady one-dimensional convection and diffusion, the central differencing scheme, properties of discretisation schemes - conservativeness, boundedness, transportiveness, Assessment of the central differencing scheme for convection-diffusion problems, The upwind differencing scheme, hybrid differencing scheme, power-law scheme, higher order differencing schemes, quadratic upwind differencing scheme.

UNIT V FINITE VOLUME METHOD FOR UNSTEADY FLOWS 9

One-dimensional unsteady heat conduction, transient convection-diffusion equation, solution procedure for unsteady flow calculations. Implementation of inlet, outlet and wall boundary conditions, constant pressure boundary condition.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the basics of CFD and governing equations for conservation of mass momentum and energy

CO2: Understand mathematical characteristics of partial differential equations

CO3: learn computational solution techniques for time integration of ordinary differential equations

CO4 gain knowledge in various discreitization techniques used in CFD

CO5: Understand flow field computation techniques for steady and unsteady flows

TEXT BOOKS

1. Versteeg H. K. and Malalasekera, W., An introduction to computational fluid dynamics: the finite volume method, Second edition, Pearson, 2008.
2. Anderson, J. D. Computational fluid dynamics: The Basics with Applications, McGraw-Hill, 1995.

REFERENCE BOOKS

1. Ranade, V. V., Computational flow modeling for Chemical Reactor Engineering, Academic Press, 2002.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basics of CFD and governing equations for conservation of mass momentum and energy	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO2	Understand mathematical characteristics of partial differential equations	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO3	learn computational solution techniques for time integration of ordinary differential equations	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO4	gain knowledge in various discreitization techniques used in CFD	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO5	Understand flow field computation techniques for steady and unsteady flows	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
Overall CO		2	2	2	2	2	2	1	1	2	2	1	2	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PEC- CHEMICAL PLANT DESIGN

CH3028 CHEMICAL PLANT DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:
- To understand the intricacies in equipment sizing and selection amongst options therein
- To leverage lessons learnt in designing chemical process unit with safety as paramount

UNIT I ROTARY EQUIPMENT 9

Pumps: Various types: Centrifugal, Reciprocating& Other Positive displacement types – Plunger, Piston, Diaphragm, Gear, Screw, Lobe, Vane, etc.; **Compressors: Various types:** Axial, Centrifugal, Reciprocating, and other positive displacement type such as Rotary Screw, Scroll, etc. Further, compressors are classified into two namely Oil free and Oil flooded lubricated; **Fans: Various types:** Axial fans (including Propeller, Tube-axial, and Vane-axial) and Centrifugal fans. Further fans are classified as Induced draft and Forced draft types; **Steam Turbines**: **: Various types:** Back Pressure and Condensing Types with and without extraction, Impulse & Reaction types; **Gas Turbines : Various types:** Turbojet, Turboprop, Turbofan and Turboshaft Engines; **Motor :Various types:** AC motors (Synchronous & Asynchronous motors), DC motors (brushed and brushless), Variable Frequency and Variable Speed motors and Special purpose motors, **Generator: Various types:** AC and DC generator; **Other Special Equipment: Various types:** Power Recovery Turbines, Heat Pumps, Ejector pump, NASH vacuum pump **Case Studies** – From Industries on operations and maintenance aspects viz. Trouble shooting, Energy improvement, Capacity augmentation, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT II STATIC EQUIPMENT - HEAT TRANSFER EQUIPMENT 9

Heat Exchangers– Shell and Tube, Double Pipe, Plate &Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; **Fired Heaters& Boilers**– With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation, **Refrigeration& Air Conditioning**– HVAC (Heating, Ventilation, and Air Conditioning); **Miscellaneous** – Chilled water system with vapour compression refrigeration, Ejector refrigeration system, direct contact heat exchanger (such as cooling towers, Jet condensers, direct contact feed), Incinerator. **Case Studies** – From Industries on operations and maintenance aspects viz. Fouling control, Pinch study for energy recovery, Capacity creep, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT III STATIC EQUIPMENT - MASS TRANSFER 9

Mass Transfer Operations: Multi Component Distillation columns, Extractive distillation, Reactive Distillation, Azeotropic distillation, Divided wall columns, Dryers, Adsorption Isotherm, Pressure Swing Adsorption, Importance of recycles and Optimization needs, Absorption processes & operating variables, Liquid – Liquid Solvent Extraction ; **Humidification** & dehumidification, Evaporation, Precipitation, Crystallizers, Membrane filtration; **Reactors**– CSTR, Slurry phase reactor, Tubular, Trickle Bed Reactor, etc., thermodynamically controlled reaction and kinetically controlled reaction, Reaction Kinetics, Importance of Reactor internals. **Case Studies** – From industries across life cycle such as Trouble shooting, enhance conversion & selectivity, IoT use, Debottlenecking, Design tips, Safety Incidents “Fit - For Purpose” Assessment, etc.

UNIT IV EQUIPMENT ANCILLARIES 9

Special equipment– Static Mixer, Agitators, Jet Mixing, Ejectors, Eductors, Structured Packing, Grid Packing and Random Packing, Demisters, Vortex Breaker, Calming Baffles, Schoepentoeter, Vapour horn device, Cyclone separators; **Package units** – Inert gas generators, Feed stream filters (Mechanical, Chemical), Scrubbers, Spray Nozzles, Guard beds, Flare stack, Ground Flare, Flame arrestors, Strainers, Spring supports, Expansion joints, Electrostatic Precipitators; **Steam Traps** – Thermodynamic, Inverted Bucket type, Thermostatic – Float, Bimetallic type, etc., **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V STATIC EQUIPMENT - PRESSURE VESSELS, INTERNALS &SAFETY VALVES 9

Pressure Vessels – Vertical / Horizontal, Knock Out Drums, Steam and Blow down drum, Cold & Hot Separators, Surge drum, Deaerators, Water Seal Pot, Molecular seals, Shock Absorbers, Pressure snubber, Silencer, Slug Catcher, Desalter, Coke drum; Vessel & Columns - associated structural accessories such as Platforms, Ladders, Staircase etc. **Internals** –Column internals such as Trays (Sieve, Valve, Bubble Cap, Baffle, Dual flow, Multi down comer, Chimney tray etc.), Packings (structured, grid, random, etc.), Packed tower internals – Bed support plates, Liquid distributors, Bed limiters etc.; Mist eliminators, Demisters, Coalescing pads, Vortex breakers etc. **Safety Valves**: Normal, balanced bellows, pilot operated, etc., Rupture Discs, and Design codes governing Safety valve design, **Case Studies**– From industrial operations & maintenance activities–ASME codes, Trouble shooting, Efficiency tracking, Use of IoT, Debottlenecking, and Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – understand the basic on designing chemical process unit for rotary equipment

CO2 – learn the operations of boilers, heat exchangers, refrigeration and air conditioners.

CO3 – knowledge on operations of reactors, humidifiers and mass transfer operations

CO4 – learn the different types of equipments in process industries

CO5 – understand the knowledge on usage of different valves such as pressure, safety and internal.

TEXTBOOKS

1. Chemical Engineering Handbook **- Robert H. Perry; Don W. Green and James O. Maloney**
2. Heat Transfer **– D.Q. Kern**
3. Mass Transfer Operations **– Robert E. Treybal**
4. Principles of Mass Transfer and separation Processes **– BK Dutta**
5. Fluid Mechanics, Heat Transfer, and Mass Transfer (Chemical Engineering Practice) **– KSN Raju**

REFERENCE BOOKS

1. Applied Process Design for Chemical and Petrochemical Plants **– Ernest E. Ludwig**

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic on designing chemical process unit for rotary equipment	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO2	learn the operations of boilers, heat exchangers, refrigeration and air conditioners	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO3	knowledge on operations of reactors, humidifiers and mass transfer operations	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO4	learn the different types of equipments in process industries	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO5	understand the knowledge on usage of different valves such as pressure, safety and internal.	2	2	2	2	2	-	1	-	2	2	2	2	2	2	1
Overall CO		2	2	2	2	2	-	1	-	2	1	2	2	2	2	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3029 **PLANT LAYOUT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the importance of plant layout in mitigating risk on people, plant, planet
- To apply knowledge in placing equipment for ease of operability & maintainability

UNIT I STANDARDS FOR AREA CLASSIFICATION 9

Standards for area classification–Electrical Area classifications, OSHA (Occupational Safety and Health Administration) regulations, National Fire Protection Association (NFPA), Petroleum Hazards Classification, IP15 Petroleum classification based on flash point, OISD standards (Oil Industry Safety Directorate), API Codes (American Petroleum Institute), PESO (Petroleum and Explosives Safety Organization) guidelines, Investigations Reports & Best practices data Chemical Safety Board, USA

Case Studies – From Industries on Lessons from Incidents from Environmental Protection Agency (EPA), Safety & Environmental Incidents, etc.

UNIT II INTER UNIT DISTANCES 9

Distance between plants, substation, centralized control room, utilities sections / captive power plants; Inter-distance between adjacent Columns, Storage tanks, Tank dykes; Flare stack location (based on Prevailing up-wind direction), Design to keep it smokeless, Sterile zone/area – Governing API /OISD Standards, Field cabins. Access to firefighting facilities, Fire tank capacity, Foam need assessment, Design to tackle simultaneous fire incidents, Protection of fire network and ensuring availability on demand, Risk evaluation(arising from inventory of inflammable liquid, potential formation of explosive mixture, operation above auto-ignition temperature, toxic release, etc.) based on credible scenario;3D models used in equipment & piping isometric, Maintenance accessibility, Safe work place specially at elevated platform, Ease of emergency evacuation; Bow Tie Analysis to mitigate risk right at design stage, Blast proof design of control room, Minimize employee occupancy at a given time in risk zone. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT III STORAGE TANKS 9

Storage Tanks – Fixed or Floating roof, Mounded Bullet tanks, Cryogenic storage tanks & their special design requirements, Special designs along with breather systems, Lightening arrestors, Earth pits, other appurtenances –Manways for roofs or tank sidewalls, Catwalks, Roof vents, Roof hatches, Nozzles, Roofs (flat-style, knuckle-style, or pitched), Aluminium geodesic domes, Ladders, etc. Comfort factors Vs Inventory carrying cost, Safe operation of floating roof travel, breather sizing, steam coils design, rainwater drains, dyke capacity, inter tank distance based on product hazard classification, tank inspection schedule, ease of cleaning, confined place entry, water spray and other firefighting feature, fugitive emission control, etc. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Water traps and roof collapse, safe filling height, Design tips, Safety & Environmental Incidents, etc.

UNIT IV AT RISK SYSTEMS AND EQUIPMENT 9

At-risk systems and equipment: Fuel gas systems, Fuel oil network, Hydrogen gas for generator cooling in power plants; Plant battery systems, Ammonia systems, Solid handling of coal and coke dust, Sulphur yard, Toxic gas loss of containment, etc, MSDS of every stream being handled / processed, Spent catalyst safe disposal ;Safe at Risk Assessment: Overall risk assessment using credible scenario along with preventive measures &systems to be in place to eliminate / minimize loss of containment. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Process Control, Early event detection, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V BASIC ENGINEERING DESIGN PACKAGE 9

Basic Engineering Design Package (BEDP): First document to be prepared and approved between Process Engineering Team and Owner's representative. It shall cover not limited to – Site Conditions (weather, wind rose, seismic activity, water table, etc.); System of measurement (in

FPS or MKS for flow of gas / liquid / steam, temperature, pressure, heat duty, inferential properties, etc.), Design considerations and margins, Design philosophies such as Operating & Control philosophy, Vent & Drain philosophy, Isolation philosophy, sparing philosophy etc. Raw material details (Capacity, conditions, logistics including receipt modes & storage criteria) Product offtake plans and modes of distribution, environmental norms, Levels of power & utilities that would be available for safe and hassle free operations ; Green belt cover, use of renewables, zero liquid discharge, maximum air cooling / condensing, storm water channel considerations, rain water harvesting ; Flare gas recovery, flight path and tall structures in industry premises, MIQA (mechanical integrity and quality assurance) considerations, equipment designed life ; Feed definition / variability / flexibility, product mix& swings, product quality, custody transfer design basis, turnaround plans ; Energy & loss targets and best in class design considerations, criteria for smooth and faster start-up, onstream factor, spinning margin, applicable codes, built in features for continual improvement, advanced process control and other s/w deployment for SCM (Supply Chain Mgt) and O&M (Operation and Maintenance) excellence. **Case Studies** – Lessons learnt from Industries viz. examples of regret investment, deviations from original design & impact thereof, market forces & design adaptability, challenges in product quality, etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – understand the importance of plant layout in mitigating risk on people, plant, planet

CO2 – understand the knowledge in placing equipment for ease of operability & maintainability

CO3 – understand the storage tanks operation and usage at safety level

CO4 – knowledge on usage of equipment at safety levels and their risk assessment

CO5 – understand the basic engineering design package

TEXTBOOKS

1. Chemical Engineering Design Principles, Practice and Economics of Plant and Process Design **- GAVIN TOWLER and RAY SINNOTT**

REFERENCE BOOKS

1. OISD Guideline on Plant Layout - OISD-STD-118
2. OSHA Guidelines on Plant Layout
3. API Guidelines on Plant layout

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the importance of plant layout in mitigating risk on people, plant, planet	2	1	2	1	2	1	1	1	1	1	2	2	2	2	2
CO2	understand the knowledge in placing equipment for ease of operability & maintainability	2	1	2	2	2	1	1	1	1	1	2	2	2	2	1
CO3	understand the storage tanks operation and usage at safety level	2	1	2	2	2	1	1	1	1	1	1	2	2	2	2
CO4	knowledge on usage of equipment at safety levels and their risk assessment	2	1	1	2	2	1	1	1	1	1	2	2	2	2	1
CO5	understand the basic engineering design package	2	1	2	2	2	1	1	1	1	1	1	2	2	2	2
Overall CO		2	1	2	2	2	1	1	1	1	1	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3030 **DESIGN SAFETY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the process safety systems both to prevent incident & to minimize loss
- To apply the principles 'safe at risk' to assess likely unsafe conditions in unit operation

UNIT I SAFETY SYSTEMS 9

Safety systems: Deployment of sensors (Toxic, HC and Thermal) at critical locations, Fire network including elevated fire monitors, Egress system, Escape route and Assembly point, Water curtain, eye wash requirement, Clean and cooler water supply ;Dovetail Early Event Detections system to forecast and forewarn on 'unsafe' conditions emerging in process units, Cause & Effect diagram, Alarm rationalization, Partial or Total Plant Trips review; Setting up IOW (Integrity Operating Window), Utility stations at strategic locations in process units (for supply of LP steam, Nitrogen, Industrial Air, Service water), Fire Proofing of structures, ROVs (Remote Operated Valves), EIVs (Emergency Isolation Valves), Redundancy in trips (1 oo 1; 2 oo 3) and avoidance of spurious trips ;SIL (Safety Integrity Level) in process safety, HIPS (High Integrity Protection System),Shutdown system reset – Field or Controlled room, Centralized Vs Decentralized Control centre, Need of Chemical filter in Control Room Air conditioning, Cyber-attack prevention, Mutual aid plan. **Case Studies** – From Peer Industries on Performance Benchmark, Process safety Management, Safety Culture, Asset Integrity, Litigations, Safety & Environmental Incidents, etc.

UNIT II ELECTRICAL SYSTEMS 9

Power systems – KV level, 3 phase and single phase, LT, HT generation and distribution network systems, MCC / PCC (motor control centre and power control centre) substations, Electrical Energy Audits, Exergy analysis, Cogen design aspects ; Emergency Power needs based on process criticalities (including power back up for fire water and plant safe shut down), Load shedding, Essential and Non- essential power load ;Uninterrupted Power System (UPS), Load assessment for UPS, Battery bank ;Earth pit design and maintenance aspects, Earth – Neutral Differential & impacts of stray voltage, Fault Level and its relevance in industry, Start-up load, Power from two independent Sources, Relay / Fuse Coordination. Electrical load distribution and its influence on safety relief / flare load in an industrial complex, Interphase with DCS (Distributed Control System), PLCs (programmable logic controls), I/P (Current to Pneumatic transmission) convertor failures ;An overview on electrical failures viz. cable fault, over load, over voltage due to surges, lightning strokes, aging of conductor, internal & external stresses on the conductors, spike in power banks, etc., **Case Studies** – Industries experiences on Steam – Power balance for efficiency enhancement, smart debottlenecking to minimize cable routing & MCC / PCC use, Safety & Environmental Incidents, etc.

UNIT III FLARE SYSTEM 9

LP, HP, LLP and H_2S flares, Types – Single Point Flares (Sonic & Subsonic), Multi Point Flares, Coanda Flares, Vent Tips, Enclosed Flares and Air Assisted Gas Flares ;Pilot gas system, Electronic ignition, Flare tip design, Flare noise reduction, Fire Ball prevention, Smokeless flare at worst weather conditions, Radiation impact zone, Flare release scenarios (fire, blocked mode, partial and total power failure), Nitrogen purge, flare header network design; Safety margins in design, Assessing flare loss in a multi units complex where metering individual headers is near impossible ;Flare gas recovery and Zero Flare release, Flare gas quality tracking and hydrogen management in refineries & petrochemicals. **Case Studies** – Industries experiences viz. Flare tips & header maintenance, Trouble shooting, Smart debottlenecking of units to limit flare load within capacity, Safety & Environmental Incidents, etc.

UNIT IV RISK MITIGATION MEASURES 9

HAZOP (Hazard and Operability Study), HAZID (Hazard identification), HAZAN (Hazard Analysis), EERA (Emergency escape route analysis), SIL (Safety Integrity levels) study, QRA (Quantitative Risk Assessment)and Dispersion studies ;Trip reset (Field and Control Room) and MSDS (Material Safety Data Sheet) for all streams being handled, Bow Tie Analysis, Risk Evaluation using 8 x 8 Matrix, FMEA (Failure Modes And Effects Analysis),Insurance premium assessment and measures to minimize ;Best practices – Updated documentation, SOPs (Standard Operating Procedures), SMPs (Standard Maintenance Procedures), PSM audits, Competency mapping and enhancement, employee loyalty programme, etc. Business risk – Risk in transportation of feed and products especially in sea routes (marine pollution); HSE norms non-compliance; Act of force majeure; etc. **Case Studies –** Industries experiences such as Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V PROCESS CONTROL & INSTRUMENTATION 9

Pneumatic (analogue controls) to DCS journey, Single loop Vs Multi loop controls, I/O cards, Graphic design & grouping to minimize user latency in process control ;Designed for safety through redundancy right from dedicated impulse lines to card level, PLC (Programmable Logic Controls), Cascaded Control, Process Historian, Online reporting by exception, Inferential predictions ;Use of AI / ML in controlling plant within best operating zone, QMIs (Quality Measuring Instruments), Alarm rationalization, Operator Fatigue ;Functional designs in delayed (by a few seconds) trip, Machine monitoring viz. signature analysis (vibration and axial displacement), surge control with differing mol wt of process gas, tribology analysis ;Emphasis on lab instrumentation to get "tell-tale" indications on existence of unsafe conditions, hand held instrumentations to work in confined space, communication system (field & control room, etc.) etc. CCTV at select places to monitor and alert well in advance. Centralized fire control panel for the whole premises by way of wired network of safety sensors. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1: learn the safety systems both to prevent incident & to minimize loss
CO2: understand the safety in electrical systems
CO3: knowledge on flare systems and their safety
CO4: get thorough knowledge on risk analysis and mitigation
CO5: knowledge on the control systems and their safety usage in different process industries

TEXTBOOKS

1. Chemical Process Safety: Fundamentals With Applications **- DANIEL A CROWL**
2. Fundamentals of Process Safety Engineering **- Samarendra Kumar Biswas**

REFERENCE BOOKS

1. Chemical Process Safety - **Aarti Kashyap**
2. Process Safety **- Klein James A and Bruce K Vaughan**

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	learn the safety systems both to prevent incident & to minimize loss	2	2	3	3	2	1	1	1	1	2	1	1	2	2	2
CO2	understand the safety in electrical systems	2	2	3	3	2	1	1	1	1	2	2	2	2	2	2
CO3	knowledge on flare systems and their safety	2	2	3	3	3	1	1	1	1	2	1	1	2	2	2
CO4	get thorough knowledge on risk analysis and mitigation	2	2	3	3	3	1	1	1	1	1	2	2	2	2	2
CO5	knowledge on the control systems and their safety usage in different process industries	2	2	3	2	2	1	1	1	1	2	1	2	2	2	2
Overall CO		2	2	3	3	2	1	1	1	1	2	1	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3031 MATERIAL SELECTION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand various degradation mechanism that engineers' face in chemical plants
- To mitigate with right choice metallurgy or chemical solution or operational changes

UNIT I CORROSION 9

Different Degradation Mechanism as seen in various Chemical process industries, Corrosion (wet H_2S, Naphthenic acid bearing Crude Processing, CO_2 stress corrosion cracking, polythionic acid formation potential, amine stress corrosion cracking, microbiologically induced corrosion, corrosion under insulation, galvanic corrosion, caustic embrittlement, introduction & diffusion of hydrogen, Chloride stress corrosion cracking, etc.) ;Monitoring and prevention, NACE (National Association of Corrosion Engineers) guidelines, Life Cycle Cost Optimization and right MOC (Material of construction), Trade-off between MOC Vs Chemical inhibitors / Additives Solutions ;'NO HARM' requirements in chemical solutions, Operation within 'best operating zone', Corrosion coupons and test methods in lab, Need & challenges in asset Integrity management, Coatings, Leak Detection & Repair. **Case Studies** – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.

UNIT II ASSETS RELIABILITY ENHANCEMENT & INCIDENT ELIMINATION 9

Risk envelope, Inputs on FERT (Fire, Explosivity, Reactivity and Toxicity), Quantification of unplanned interruption viz. impact on Safety, Environment and Loss of properties / business erosion, Early Event Detection using AI / ML, Surface Chemistry, Advanced Lab Techniques (SEM - Scanning Electron Microscopy, Corrosion probes, Field Signature Method, Non-intrusive techniques, Ultimate Analysis, Atomic ratios on debris, Tell-Tale Indications, etc.), **Case Studies** – From Industries on process / equipment reliability viz. Asset integrity, Asset sweating within safe operating window, Design errors, Safety & Environmental Incidents, Human factors, etc.

UNIT III FLOW AND ACOUSTIC INDUCED VIBRATION IN PIPES 9

Flow Induced Vibration in pipes: Flow regimes – Slug flow, plug flow, annular, dispersed, etc. Flows in Vertical and Horizontal pipes, Design criticalities in two phase (gas & liquid) and slurry flow (solid and liquid), Handling of steam condensate& prevention of water hammering, Piping Configurations for symmetrical flow distribution, Use CFD (Computational Fluid Dynamics) to assess - selective erosion in some section of pipes, cycling pattern of vibration, heat flux or fluid film temperature variation in heater tubes, etc., Suitability of Material of Constructions for different operating severity and feed stocks including changes in process conditions during start up, shut down, catalyst pre-sulphating, etc. **Acoustic induced vibrations** in pipes due to high velocity gas streams in pipes (Near sonic velocity conditions). **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting and controlling flow regimes to avoid vibration, Design tips, Safety & Environmental Incidents, etc.

UNIT IV FOULING AND COKING 9

Asphaltenes precipitation, Wax deposits, Gum formation, Ageing of hydrocarbon on prolonged storage and filter plugging ;Dewatering and prevention of ingress of corrosion products leading to fouling, dead zone (stagnant) prevention, Inserting storage tanks to avoid oxidation induced feed / product degradation, Incompatibility of mixing, Shear stress assessment, Assessment of Coke precursors and elimination / removal during processing ;Chemical (anti-foulant) additives to mitigate fouling / coking, process variables impacting fouling specially in exchangers, heater pipes and column internals, Methods of decoking – steam-air decoking, mechanical, pigging and spalling ;Use of quench oil in gas / naphtha cracker heaters to keep asphaltenes in suspension, polymerisation prevention, hypothesis on coking viz. pyrolytic coke, filamentous coke, amorphous coke formation, etc. **Case Studies** – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.

UNIT V ADVANCEMENT IN MATERIAL SCIENCE 9

Academy to list the course content including use of graphene, metal organic framework, super conductors, replacement of Lithium for battery making, etc. In addition, Nano materials, there are lot more efforts needed to minimize dependence on import for some of the metals used in catalyst, defence needs, etc. which can only be substituted with effective end application needs and metallurgy and or alloy use. **Case Studies** – From market and strategic needs.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – understand the basic concept on corrosion and their types in chemical industry

CO2 – know the degradation mechanism that engineers' face in chemical plants

CO3 –recognize the different flows in pipes and their acoustic induced vibrations

CO4 - gain knowledge in the concept of fouling in pipes and different methods of decoking

CO5 – gather some knowledge on advancement in material science usage.

TEXTBOOKS

1. Corrosion Mechanisms (Chemical Industries) **- Florian Mansfeld**
2. Organic Chemicals in the Environment Mechanisms of Degradation and Transformation **- Alasdair H. Neilson, Ann-Sofie Allard**

REFERENCE BOOKS

1. NACE documents - **American Petroleum Institute (API) 571 standards**

COURSE ARTICULATION MATRIX:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basic concept on corrosion and their types in chemical industry	2	-	-	-	1	2	2	2	2	1	2	2	2	2	2
CO2	know the degradation mechanism that engineers' face in chemical plants	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2
CO3	recognize the different flows in pipes and their acoustic induced vibrations	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2
CO4	gain knowledge in the concept of fouling in pipes and different methods of decoking	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	gather some knowledge on advancement in material science usage	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2
Overall CO		2	2	2	2	1	2	2	2	2	1	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3032 STATUTORY REQUIREMENTS AND CUSTOMER CARE **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the purpose of competitive edge within the regulatory systems set
- To leverage learning to become SMART manufacturer within norms of responsive care

UNIT I PEOPLE AND PROCESS SAFETY 9

Factory Act, IBR (Indian Boiler Regulations), Weights & Measures, Power Connection from State Electricity Board, Labour Legislation, Compensation, Fines, Litigations, Image, etc. and other commercial approvals like company registration, GST Registration, IT act, Excise Regulations etc. For operations under EOU (Export oriented units) or SEZ (Special Economic Zones), take additional approval from Export Processing Zone (EPZ) and SEBI. **Case Studies** – Assess the number of days taken for all such approval and apply LEAN to crunch time.

UNIT II ENVIRONMENTAL REGULATIONS 9

Water act, Air act, for highly polluting industry category EIA (Environment Impact Assessment) is mandatory, Environmental Protection Act, Licence needed for 'Drugs & Pharmaceuticals' from State Drug Controller, Hazardous substance management, Waste Management rules, Pollution Control Boards / Consent to operate (State and Union Government) specially for Industries Requiring Water and Affecting Effluent Disposal… **Case Studies** – Assess the number of days taken for all such approval and apply LEAN to crunch time. Additionally, benchmark on HSE norms to compare with peer industries for improvement options.

UNIT III CUSTOMER CARE 9

Customer definition, Kano Model, CRM, PFABFS model (Property, Feature, Advantage, Benefit and Savings both monetary and emotional value); Product Supply Specification based on end use applications with competitive edge over peer industries; Quality Cost, Custody transfer precision, Wing to Wing co-operation with customers / suppliers to enhance value chain returns; Development of new products and services – Ideation, proof of concept, pilot run & commercialization. **Case Studies** – Products & Services that made difference, Companies that disappeared when changes were not picked up in time, Point of Sale tips for lasting impression, Cycle time to launch new product.

UNIT IV INTERNSHIP PREPARATION AND DO'S & DON'TS 9

Safety Contact, Mandatory use of PPE, Assembly points, Alarm station, Mock drills, Firefighting apparatus use on demand, know the escape routes; Shadow the trainer, learning objective – pick any one viz. Catalysis – past say three to five catalyst change, the conversion variation, generation of low value side reactions, sintering & loss of margin, H_2 loss, any tell-tale indications from apple core tests of spent catalyst, Deep dive into design of say, heat exchangers network with a view to achieve O&M excellence, Asset reliability – O&M efforts to continuously track PSM critical equipment, Energy benchmarking, Overall processing margins against best in class peer industries, Inventory management and assessment of revenue by blocked investment, Water management, etc. **Case studies** – In nearby cluster of industries at Tamil Nadu, assess O&M gaps and work to bridge the gap, learn about competencies gaps, past LFIs with RCA initiated, etc.

UNIT V SUSTAINABILITY REPORTING 9

Understanding aspects like 'Net Zero Concept', Green House Gases release reduction, ZLD (zero Liquid discharge), Benefits to the society, Concepts of linear economy and circular economy, Life Cycle Analysis, Think Global and Act Local, learn on 17 Sustainable Development Goals as per UN charter, Use Global Reporting Initiative (GRI) formats for Sustainability reporting, **Project assignment** – Work on Sustainability reporting for nearby cluster of industries in Tamil Nadu

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to
CO1 – understand the basis on different acts and their regulations
CO2 – basic knowledge in different ACT on water, air and environmental protection
CO3 – knowledge on the preparation of Kano model, CRM, PFABFS

CO4 – gain the knowledge on Do's and Don'ts in an internship program
CO5 – understand the concepts of ZLD, GHG release and circular economy

TEXTBOOKS

1. Beyond Competitive Advantage **- Todd Zenger, 2016**
2. Competitive Advantage: Creating and Sustaining Superior performance **– Michael E. Porter**

REFERENCE BOOKS

1. Sustainability What Everyone Needs to Know **- Paul B. Thompson, Patricia E. Norris**

Course Articulation matrix:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	understand the basis on different acts and their regulations	2	-	-	-	-	2	1	1	1	2	2	2	2	2	2
CO2	basic knowledge in different ACT on water, air and environmental protection	2	-	-	-	2	1	1	1	1	2	2	2	2	2	2
CO3	knowledge on the preparation of Kano model, CRM, PFABFS	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2
CO4	gain the knowledge on Do’s and Don’ts in an internship program	2	-	-	-	2	1	1	1	2	2	1	2	2	2	2
CO5	understand the concepts of ZLD, GHG release and circular economy	2	-	1	2	2	1	1	1	1	2	1	2	2	2	2
Overall CO		2	1	1	1	2	1	1	1	1	2	1	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CH3033 PROCESS PLANT UTILITIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the design and management of utilities system in any chemical industry
- To apply energy conservation techniques right at design and strive net zero emission

UNIT I BASIC UTILITIES 9

Air (Industrial Service and Instrument), Cold Box air Liquification Plant, Nitrogen, Inert gas generation; Water (Potable, Service, Utility, Cooling Boiler Feed water, DM water, Desal water, RO permeate, etc.); Steam (High Pressure, Medium, Low and Very Low-pressure system), Condensate Polishing, Hot oil system, Thermic fluids for energy supply to Process equipment. Associated control equipment to monitor and prevent Water Pollution, Air Pollution control equipment, Solid waste storage area as per Waste management Rules. Also, discuss about the need to control slop generation in chemical industries. **Case Studies –** From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT II POWER GENERATION & DISTRIBUTION 9

Power Generation & Distribution: Gas turbines (types of fuel Vs operational reliability), Open and closed cycle, Steam Turbine generators, Power Recovery Turbo generators, IC Engines Power Generators, Renewables Power – Solar, Wind, Waves, Geo thermal, Biomass, Fuel Gas / Fuel Oil network, Impacts of utility failures (partial and or full).**Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT III WASTEWATER TREATMENT 9

Wastewater Treatment: Bioremediation, WWTP (Wastewater Treatment Plants along with separation system and biochemical processes to reduce BOD / COD (Biochemical Oxygen Demand and Chemical Oxygen Demand), Recalcitrant material adding to COD, Considerations in deployment of RO Membrane and reuse of treated water. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT IV GAS PROCESSING 9

LNG/ CNG, Refinery Gas Treating, Sour Gas Processing, Amine Absorption and Regeneration Processes, Sulphur Recovery & Removal, Gas dehydration & Dew pointing. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V COOLING WATER SYSTEM 9

Cooling water System: Cooling towers (CT), Wet and Dry Bulb and its relation to CT performance, Induced Vs Natural Draft CT, COC (Cycle of Concentration), Minimize / eliminate drift loss, CW network, assessment of cooling effectiveness in multiple parallel exchangers with availability of combined flow. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1: gain knowledge in the importance of process plant utilities
CO2: Understand the Requisites of Industrial Water and treatment methodologies
CO3: be familiar on various types of steam generators and boiler corrosion
CO4: Understand the concept of refrigeration used in industries
CO5: Learn the classification of compressors and humidification equipments

TEXTBOOKS

1. Introduction to Process Engineering and Design **– Shuchen B Thakore & Bharat I Bhatt (2017) McGraw Hill 2nd Edition.**
2. Plant Utilities **- D. B. DHONE** Publisher Nirali Prakashan, 2018

REFERENCE BOOKS

1. A Working Guide to Process Equipment **- Norman Lieberman, Elizabeth Lieberman**

Course Articulation matrix:

Course Outcomes	Statements	Program Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	gain knowledge in the importance of process plant utilities	2	-	-	-	-	1	1	1	1	2	2	2	2	2	2
CO2	Understand the Requisites of Industrial Water and treatment methodologies	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO3	be familiar on various types of steam generators and boiler corrosion	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO4	Understand the concept of refrigeration used in industries	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO5	Learn the classification of compressors and humidification equipments	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2
Overall CO		2	2	2	2	2	1	1	1	1	2	2	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

GE3751 **PRINCIPLES OF MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers-managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2: Have same basic knowledge on international aspect of management.
CO3: Ability to understand management concept of organizing.
CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling.

TEXT BOOKS:

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

REFERENCES:

1. Robert Kreitner and MamataMohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.

3. Tripathy PC and Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999.

CO’s, PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
AVg.	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

1-Low,2-Medium,3-High,”-“-no correlation

GE3752 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQMframework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking andFMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniqueslike QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation- Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM:

Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 : Ability to apply TQM concepts in a selected enterprise.
CO2: Ability to apply TQM principles in a selected enterprise.
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking andFMEA.
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and applyQFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1 Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition,2003.
4. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006 .

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3										3	2		3
2						3						3		2	
3					3				3					2	3
4		2			3	2	3	2				3	3	2	
5			3			3	3	2							
AVg.		2.5	3		3	2.6	3	2	3			3	2.5	2	3

1-Low,2-Medium,3-High,”-“-no correlation

GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better
- understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

UNIT I DEMAND & SUPPLY ANALYSIS 9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

UNIT II PRODUCTION AND COST ANALYSIS 9

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function.
Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

UNIT III PRICING 9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Students able to

CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2: Evaluate the economic theories, cost concepts and pricing policies
CO3: Understand the market structures and integration concepts
CO4: Understand the measures of national income, the functions of banks and concepts of globalization
CO5: Apply the concepts of financial management for project appraisal

TEXT BOOKS:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

REFERENCES:

1. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

MAPPING OF COS AND POS:

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3								2			1	3	
2		3												2	2
3		2													
4	2	3	3		2								2	3	
5	3	3	3		2								2		2
AVg.	2.5	2.4	3		2					2			1.8	2.6	2

1-Low,2-Medium,3-High,”-“-no correlation

GE3754 HUMAN RESOURCE MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVE:

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

UNIT II HUMAN RESOURCE PLANNING 9

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9

Types of training and Executive development methods – purpose – benefits.

UNIT IV EMPLOYEE COMPENSATION 9

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

UNIT V PERFORMANCE EVALUATION AND CONTROL 9

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students would have gained knowledge on the various aspects of HRM
CO2: Students will gain knowledge needed for success as a human resources professional.
CO3: Students will develop the skills needed for a successful HR manager.
CO4: Students would be prepared to implement the concepts learned in the workplace.
CO5: Students would be aware of the emerging concepts in the field of HRM

TEXT BOOKS:

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

REFERENCES:

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, “Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
AVg.	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1

1-Low,2-Medium,3-High,”-“-no correlation

GE3755 **KNOWLEDGE MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The student should be made to:

Learn the Evolution of Knowledge management.

- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

UNIT I INTRODUCTION 9

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V FUTURE TRENDS AND CASE STUDIES 9

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Understand the process of acquiry knowledge from experts

CO2: Understand the learning organization.

CO3: Use the knowledge management tools.

CO4: Develop knowledge management Applications.

CO5: Design and develop enterprise applications.

CO's- PO's & PSO's MAPPING

CO's	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1					1										
2					2								1		
3					2									2	
4				1	1				1					1	
5				1	1				1					1	
AVg.				1	1.4				1				1	1.33	

1-Low,2-Medium,3-High,"-"-no correlation

TEXT BOOK:

1. Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

REFERENCE:

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

GE3792 INDUSTRIAL MANAGEMENT

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

UNIT – I INTRODUCTION TO MANAGEMENT 9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT – II FUNCTIONS OF MANAGEMENT - I 9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNIT – III FUNCTIONS OF MANAGEMENT - II 9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT – IV ORGANIZATION THEORY 9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT – V PRODUCTIVITY AND MODERN TOPICS 9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

CO2 Discuss the planning; organizing and staffing functions of management in professional organization.

CO3 Apply the leading; controlling and decision making functions of management in professional organization.

CO4 Discuss the organizational theory in professional organization.

CO5 Apply principles of productivity and modern concepts in management in professional organization.

TEXTBOOKS:

1 M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.

2 Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCES:

1 Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.

2 Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.

3 S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.

4 Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.

5 S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

MAPPING OF COS AND POS:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

1-Low,2-Medium,3-High,"-"-no correlation

MANDATORY COURSES I

MX3081 INTRODUCTION TO WOMEN AND GENDER STUDIES

L	T	P	C
3	0	0	0

COURSE OUTLINE

UNIT I CONCEPTS

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

UNIT II FEMINIST THEORY

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

UNIT III WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL

Rise of Feminism in Europe and America.
Women's Movement in India.

UNIT IV GENDER AND LANGUAGE

Linguistic Forms and Gender.
Gender and narratives.

UNIT V GENDER AND REPRESENTATION

Advertising and popular visual media.

Gender and Representation in Alternative Media.
Gender and social media.

TOTAL : 45 PERIODS

MX3082 ELEMENTS OF LITERATURE

L	T	P	C
3	0	0	0

OBJECTIVE:

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

1. COURSE CONTENTS

Introduction to Elements of Literature

1. **Relevance of literature**
   a) Enhances Reading, thinking, discussing and writing skills.
   b) Develops finer sensibility for better human relationship.
   c) Increases understanding of the problem of humanity without bias.
   d) Providing space to reconcile and get a cathartic effect.

2. **Elements of fiction**
   a) Fiction, fact and literary truth.
   b) Fictional modes and patterns.
   c) Plot character and perspective.

3. **Elements of poetry**
    a) Emotions and imaginations.
    b) Figurative language.
    c) (Simile, metaphor, conceit, symbol, pun and irony).
    d) Personification and animation.
    e) Rhetoric and trend.

4. **Elements of drama**
    a) Drama as representational art.
    b) Content mode and elements.
    c) Theatrical performance.
    d) Drama as narration, mediation and persuasion.
    e) Features of tragedy, comedy and satire.

3. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

3.1 Textbook:

3.2 *Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

4. OTHER SESSION:

4.1*Tutorials:

4.2*Laboratory:

4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

5.*ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

TOTAL : 45 PERIODS

OUTCOME OF THE COURSE:

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

MX3083 **FILM APPRECIATION** **L T P C**
3 0 0 0

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

Theme - A: The Component of Films

A-1: The material and equipment
A-2: The story, screenplay and script
A-3: The actors, crew members, and the director
A-4: The process of film making… structure of a film

Theme - B: Evolution of Film Language

B-1: Film language, form, movement etc.
B-2: Early cinema… **silent film** (Particularly French)
B-3: The emergence of feature films: **Birth of a Nation**
B-4: Talkies

Theme - C: Film Theories and Criticism/Appreciation

C-1: Realist theory; Auteurists
C-2: Psychoanalytic, Ideological, Feminists
C-3: How to read films?
C-4: Film Criticism / Appreciation

Theme – D: Development of Films

D-1: Representative Soviet films
D-2: Representative Japanese films
D-3: Representative Italian films
D-4: Representative Hollywood film and the studio system

Theme - E: Indian Films

E-1: The early era
E-2: The important films made by the directors
E-3: The regional films
E-4: The documentaries in India

READING:

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

MX3084 **DISASTER RISK REDUCTION AND MANAGEMENT** **L T P C**
3 0 0 0

COURSE OBJECTIVE

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

UNIT I HAZRADS, VULNERABILITY AND DISASTER RISKS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

UNIT II DISASTER RISK REDUCTION (DRR) 9

Sendai Framework for Disaster Risk Reduction**,** Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III DISASTER MANAGEMENT 9

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

UNIT V DISASTER MANAGEMENT: CASE STUDIES 9

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

TOTAL : 45 PERIODS

TEXT BOOKS:

1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

REFERENCES

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

COURSE OUTCOME:

CO1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)

CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction

CO3: To develop disaster response skills by adopting relevant tools and technology

CO4: Enhance awareness of institutional processes for Disaster response in the country and

CO5: Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

CO's – PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
AVG	3	3	3	3	-	-	2	2	-	-	2	-	2	-	1

1-Low,2-Medium,3-High,"-"-no correlation

MANDATORY COURSES II

MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA **L T P C**
3 0 0 0

COURSE OBJECTIVES:

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

UNIT I HEALTH AND ITS IMPORTANCE 2+4

Health: Definition - Importance of maintaining health - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath.

Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

UNIT II DIET 4+6

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension

– PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet
Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes
Different cooking methods, merits and demerits of each method

UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.
Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.
Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Pancheekarana Theory / **(**Five Element Theory) 96 fundamental Principles - Uyir Thathukkal **(**Tri-Dosha Theory) - Udal Thathukkal
Prevention of illness with our traditional system of medicine
Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

UNIT IV MENTAL WELLNESS 3+4

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

Sleep - Sleep and its importance for mental wellness - Sleep and digestion.
Immunity - Types and importance - Ways to develop immunity

UNIT V YOGA 2+12
Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

REFERENCES:
1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/
2. **Simple lifestyle modifications to maintain health** https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.
3. **Read more**: https://www.legit.ng/1163909-classes-food-examples-functions.html
4. https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926
5. **Benefits of healthy eating** https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html
6. **Food additives** https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives
7. **BMI** https://www.hsph.harvard.edu/nutritionsource/healthy-weight/
https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations
8. **Yoga** https://www.healthifyme.com/blog/types-of-yoga/
https://yogamedicine.com/guide-types-yoga-styles/
Ayurveda : https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda
9. **Siddha** : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp
10. **CAM :** https://www.hindawi.com/journals/ecam/2013/376327/
11. **Preventive** herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

COURSE OUTCOMES:
After completing the course, the students will be able to:
- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

MX3086 HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA L T P C
3 0 0 0

UNIT-I CONCEPTS AND PERSPECTIVES
Meaning of History
Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.
Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA
Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA
Technology in pre-historic period
Beginning of agriculture and its impact on technology
Science and Technology during Vedic and Later Vedic times
Science and technology from 1st century AD to C-1200.

UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA
Legacy of technology in Medieval India, Interactions with Arabs
Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
Astronomy and Mathematics: interaction with Arabic Sciences
Science and Technology on the eve of British conquest

UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA
Science and the Empire
Indian response to Western Science
Growth of techno-scientific institutions

UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA
Science, Technology and Development discourse
Shaping of the Science and Technology Policy
Developments in the field of Science and Technology
Science and technology in globalizing India
Social implications of new technologies like the Information Technology and Biotechnology

TOTAL: 45 PERIODS

MX3087	**POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY**	**L T P C**
		3 0 0 0

Pre-Requisite**:** None. (Desirable: Universal Human Values 1, Universal Human Values 2)

OBJECTIVES:

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fullfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

COURSE TOPICS:
Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

Conclusion (2 lectures)

Total lectures: 39

Preferred Textbooks: See Reference Books

Reference Books: Authors mentioned along with topics above. Detailed reading list will be provided.

GRADING:

Mid sems	30
End sem	20
Home Assign	10
Term paper	40

TOTAL: 45 PERIODS

OUTCOME:

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

MX3088 STATE, NATION BUILDING AND POLITICS IN INDIA **L T P C**
3 0 0 0

OBJECTIVE:

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

TOPICS:

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,
The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.
Goals, objective and philosophy.
Why a federal system?
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)
New social movements.
The changing nature of Indian Political System, the future scenario.
What can we do?

OUTCOME OF THE COURSE:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

SUGGESTED READING:

i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
iv. Sumantra Bose, Transforming India: Challenges to the World’s Largest Democracy, Picador India, 2013.
v. Atul Kohli, Democracy and Discontent: India’s Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

TOTAL: 45 PERIODS

MX3089 INDUSTRIAL SAFETY **L T P C**
3 0 0 0

OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT I SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT III SAFETY ACTIVITIES

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT IV WORKPLACE HEALTH AND SAFETY

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT V HAZARD IDENTIFICATION TECHNIQUES

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

COURSE OUTCOMES

Course outcomes on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

TEXTBOOKS

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCES

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England
5. Society of Safety Engineers, USA

ONLINE RESOURCES

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization https://www.iso.org/standard/63787.html

Indian Standard code of practice on occupational safety and health audit https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf

CO's, PO's & PSO's MAPPING

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basic concept of safety.	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	Obtain knowledge of Statutory Regulations and standards.	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	Know about the safety Activities of the Working Place.	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	Analyze on the impact of Occupational Exposures and their Remedies	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	Obtain knowledge of Risk Assessment Techniques.	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3
Average		3	3	3	2	1	3	2	2	3	2	1	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPEN ELECTIVE I AND II

OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

L	T	P	C
2	0	2	3

OBJECTIVES:

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6

Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6

Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

UNIT III LEARNING 6

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

UNIT IV SUPERVISED LEARNING 6

Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree:** Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines** (SVM)

UNIT V UNSUPERVISED LEARNING 6

Unsupervised Learning – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

TOTAL : 30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

Programs for Problem solving with Search

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A* algorithms.

Supervised learning

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

Unsupervised learning

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

OUTCOMES:

CO1: Understand the foundations of AI and the structure of Intelligent Agents
CO2: Use appropriate search algorithms for any AI problem
CO3: Study of learning methods
CO4: Solving problem using Supervised learning
CO5: Solving problem using Unsupervised learning

TOTAL PERIODS: 60

TEXT BOOK

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

REFERENCES

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

OCS352	**IOT CONCEPTS AND APPLICATIONS**	**L T P C**
		2 0 2 3

OBJECTIVES:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

UNIT I INTRODUCTION TO INTERNET OF THINGS 5

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

UNIT II COMPONENTS IN INTERNET OF THINGS 5

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV OPEN PLATFORMS AND PROGRAMMING 7

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT V IOT APPLICATIONS 7

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5 Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10.Design an IOT based system

OUTCOMES:

CO 1: Explain the concept of IoT.
CO 2: Understand the communication models and various protocols for IoT.
CO 3: Design portable IoT using Arduino/Raspberry Pi /open platform
CO 4: Apply data analytics and use cloud offerings related to IoT.
CO 5: Analyze applications of IoT in real time scenario.

TOTAL PERIODS:60

TEXTBOOKS

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

REFERENCES

1. Perry Lea, “Internet of things for architects”, Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
6. https://www.arduino.cc/
https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

OCS353 DATA SCIENCE FUNDAMENTALS L T P C
2 0 2 3

COURSE OBJECTIVES:

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.

- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

UNIT I INTRODUCTION 6

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

UNIT II DATA MANIPULATION 9

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

UNIT III MACHINE LEARNING 5

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

UNIT IV DATA VISUALIZATION 5

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

UNIT V HANDLING LARGE DATA 5

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

LAB EXERCISES

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
    a) Frequency distributions
    b) Mean, Mode, Standard Deviation
    c) Variability
    d) Normal curves
    e) Correlation and scatter plots
    f) Correlation coefficient
    g) Regression

6. Use the standard benchmark data set for performing the following:
a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.

COURSE OUTCOMES:
At the end of this course, the students will be able to:

CO1: Gain knowledge on data science process.
CO2: Perform data manipulation functions using Numpy and Pandas.
CO3 Understand different types of machine learning approaches.
CO4: Perform data visualization using tools.
CO5: Handle large volumes of data in practical scenarios.

TOTAL:60 PERIODS

TEXT BOOKS
1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

REFERENCES
1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press,2014.

CCS333 AUGMENTED REALITY/VIRTUAL REALITY

L	T	P	C
2	0	2	3

OBJECTIVES:
- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

UNIT I INTRODUCTION 7
Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

UNIT II VR MODELING 6
Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

UNIT III VR PROGRAMMING 6
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

UNIT IV APPLICATIONS 6
Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

UNIT V AUGMENTED REALITY 5

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, the students will be able to:

CO1: Understand the basic concepts of AR and VR

CO2: Understand the tools and technologies related to AR/VR

CO3:Know the working principle of AR/VR related Sensor devices

CO4: Design of various models using modeling techniques

CO5: Develop AR/VR applications in different domains

TEXTBOOKS:

1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016
3. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003

CO’s – PO’s & PSO’s MAPPING

CO’s	PO’s													PSO’s		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	
1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2	
2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2	
3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2	
4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2	
5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3	
AVg.	**3.00**	**2.60**	**2.40**	**2.00**	**3.00**	-	-	-	**2.80**	**2.20**	**1.80**	**2.60**	**2.80**	**1.80**	**2.20**	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPEN ELCTIVE III

OHS351 ENGLISH FOR COMPETITIVE EXAMINATIONS L T P C
3 0 0 3

Course Description:

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

OBJECTIVES:

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

UNIT I 9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

UNIT II 9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

UNIT III 9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

UNIT IV 9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

UNIT V 9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

TOTAL: 45 PERIODS

Learning Outcomes:

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence

- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-
2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
AVg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix.

Teaching Methods:

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

Evaluative Pattern:

Internal Tests – 50%
End Semester Exam - 50%

TEXTBOOKS:

1. R.P.Bhatnagar - *General English for Competitive Examinations.* Macmillan India Limited, 2009.

REFERENCEBOOKS:

1. Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.
2. The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.
3. R Rajagopalan- General English for Competitive Examinations, McGraw Hill Education (India) Private Limited, 2008.

Websites

http://www.examenglish.com/, http://www.ets.org/ , http://www.bankxams.com/
http://civilservicesmentor.com/, http://www.educationobserver.com
http://www.cambridgeenglish.org/in/

OMG352 NGOS AND SUSTAINABLE DEVELOPMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES

- .to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- to comprehend the role of NGOs in attaining sustainable development

Unit I ENVIRONMENTAL CONCERNS 9

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

UNIT II ROLE OF NGOS 9

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

UNIT III SUSTAINABLE DEVELOPMENT 9

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

UNIT IV NGO'S FOR SUSTAINABILITY 9

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

UNIT V LEGAL FRAMEWORKS 9

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

TOTAL : 45PERIODS

OUTCOMES

Upon completion of this course, the student will :

CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development

CO2 have a knowledge on the role of NGOs towards sustainable developemnt

CO 3 present strategies for NGOs in attaining sustainable development

CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment

CO 5 understand the environmental legislations

REFERENCE BOOKS

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

OCE353 LEAN CONCEPTS, TOOLS AND PRACTICES L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

UNIT I INTRODUCTION 9

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress

Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

UNIT II LEAN MANAGEMENT 9

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

UNIT III CORE CONCEPTS IN LEAN 9

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

UNIT IV LEAN TOOLS AND TECHNIQUES 9

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

TOTAL : 45 PERIODS

OUTCOME:

On completion of this course, the student is expected to be able to

CO1 Explains the contemporary management techniques and the issues in present scenario.
CO2 Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
CO3 Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
CO4 Apply lean techniques to achieve sustainability in construction projects.
CO5 Apply lean construction techniques in design and modeling.

REFERENCES:

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

OMG353 DEMOCRACY AND GOOD GOVERNANCE **L T P C**
3 0 0 3

UNIT-I **(9)**
Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

UNIT-II **(9)**
Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

UNIT-III **(9)**
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

UNIT- IV **(9)**
Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

UNIT-V **(9)**
Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

TOTAL 45 : PERIODS

REFERENCES:

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India,2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

CME365 RENEWABLE ENERGY TECHNOLOGIES **L T P C**
3 0 0 3

COURSE OBJECTIVES
1 To know the Indian and global energy scenario
2 To learn the various solar energy technologies and its applications.
3 To educate the various wind energy technologies.
4 To explore the various bio-energy technologies.
5 To study the ocean and geothermal technologies.

UNIT – I ENERGY SCENARIO **9**
Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY **9**
Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT – III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT – IV BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

TEXT BOOKS:

- Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

CO's, PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	2	3	2	2	1	1	3	2	1	2
2	3	2	2	1	1	1	3	1	1	1	2	3	2	1	2
3	3	2	3	1	2	1	3	1	1	1	1	3	1	1	2
4	2	2	2	1	2	1	3	1	1	1	2	3	2	2	2
5	2	1	2	1	2	1	3	1	1	1	1	3	2	1	2
Low (1) ; Medium (2) ; High (3)															

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OME354 **APPLIED DESIGN THINKING** **L T P C**
3 0 0 3

OBJECTIVES:
The course aims to
- Introduce tools & techniques of design thinking for innovative product
- development Illustrate customer-centric product innovation using on simple
- use cases Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

UNIT I DESIGN THINKING PRINCIPLES 9
Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION 9
Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

UNIT III APPLIED DESIGN THINKING TOOLS 9
Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

UNIT IV CONCEPT GENERATION 9
Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

UNIT V SYSTEM THINKING 9
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, learners will be able to:
- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

TEXT BOOKS

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), “Thinking in Systems -A Primer”, Sustainability Institute.
5. Tim Brown,(2012) “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Business.

REFERENCES
1. https://www.ideou.com/pages/design-thinking#process
2. https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86 24
3. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356
4. https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e
5. https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd
6. https://blog.forgefor ward.in/star tup-failure-is-like-true-lie-7812cdfe9b85

MF3003 REVERSE ENGINEERING LT P C
3 0 0 3

COURSE OBJECTIVES:
- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

UNIT I INTRODUCTION & GEOMETRIC FORM 9 Hours
Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9 Hours
.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III DATA PROCESSING 9 Hours
Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV 3D SCANNING AND MODELLING 9 Hours
Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V INDUSTRIAL APPLICATIONS 9 Hours
Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
- Apply the fundamental concepts and principles of reverse engineering in product design

and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

TEXT BOOKS:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

REFERENCES:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer-Verlag London Limited 2008.

OPR351	**SUSTAINABLE MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:
- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT – I ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT – III SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model.

UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

CO's, PO's & PSO's MAPPING

Mapping of COs with POs and PSOs															
COs/Pos &PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2		-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO/PO & PSO Average	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

1-Low,2-Medium,3-High,"-"-no correlation

TEXT BOOKS:

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

REFERENCES:

1. Jovane F, Ęmper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012, ISBN 978-3-642-27289-9.

AU3791 ELECTRIC AND HYBRID VEHICLES L T P C
3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II ENERGY SOURCES 9

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion-Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III MOTORS AND DRIVES 9

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV POWER CONVERTERS AND CONTROLLERS 9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

UNIT V HYBRID AND ELECTRIC VEHICLES 9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the student will be able to

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.
4. Explain the role of power electronics in hybrid and electric vehicles
5. Analyze the energy and design requirement for hybrid and electric vehicles.

TEXT BOOKS:

1. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRCPress,2005.

REFERENCES:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

CO's, PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	1		3	2					2		1	3
2	1	1	2	1		3	2					2		1	3
3	1	1	2	1		3	2					2		1	3
4	1	1	2	1		3	2					2		1	3
5	1	1	2	1		3	2					2		1	3
Avg.	1	1	2	1		3	2					2		1	3

1-Low,2-Medium,3-High,"-"-no correlation

OAS352 SPACE ENGINEERING **L T P C**
3 0 0 3

OBJECTIVES:

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

UNIT I STANDARD ATMOSPHERE 6

History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II AERODYNAMICS 10

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

UNIT III PERFORMANCE AND PROPULSION 9

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

UNIT V SPACE APPLICATIONS 10

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

OUTCOMES:

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS:

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, " Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

REFERENCE:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

OIM351 INDUSTRIAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management

UNIT I INTRODUCTION 9

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

UNIT II FUNCTIONS OF MANAGEMENT 9

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

UNIT III ORGANIZATIONAL BEHAVIOUR 9

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

UNIT IV GROUPDYNAMICS 9

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

UNIT V MODERN CONCEPTS 9

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the basic concepts of industrial management

CO2: Identify the group conflicts and its causes.

CO3: Perform swot analysis

CO4 : Analyze the learning curves

CO5 : Understand the placement and performance appraisal

REFERENCES:

Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, sixth 2008

CO’s, PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1											2	1	
2		3	2	3											2
3	2	3	2	3									1	2	3
4	2	2	3	3										3	3
5	2	2											2		
AVg.	2	2.2	2.3	3									1.8	2	2.6

1-Low,2-Medium,3-High,”-“-no correlation

OIE354 QUALITY ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing thespecialcontrolproceduresforserviceandprocessorientedindustries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

UNIT I INTRODUCTION 9

Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance–Quality planning-Quality costs–Economics of quality– Quality loss function

UNIT II CONTROLCHARTS 9

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.

UNIT III SPECIAL CONTROL PROCEDURES 9

Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

UNIT IV STATISTICALPROCESSCONTROL 9

Process stability, process capability analysis using a Histogram or probability plots and control chart.Gauge capability studies,setting specification limits.

UNITV ACCEPTANCESAMPLING 9

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL-STD-414E&IS2500 standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Students will be able to:
CO1: Control the quality of processes using control charts for variables in manufacturing industries.
CO2: Control the occurrence of defective product and the defects in manufacturing companies.
CO3: Control the occurrence of defects in services.
CO4: Analyzing and understanding the process capability study.
CO5: Developing the acceptance sampling procedures for incoming raw material.

CO's, PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	3		3			1	2			2	1		
2		3	3		3	3			3			3		2	
3	3	3	3		3				3			3	1		
4	3		2		3						1		1		
5		2			3				3			3			1
AVg.	2.6	2.7	2.7		3	3		1	2.7		1	2.7	1	2	1

1-Low,2-Medium,3-High,"-"-no correlation

OSF351 FIRE SAFETY ENGINEERING **L T P C**
3 0 0 3

COURSE OBJECTIVES
- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and quality-based study programmes

UNIT I INHERENT SAFETY CONCEPTS 9
Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

UNIT II PLANT LOCATIONS 9
Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements- standard heating condition, Indian standard test method, performance criteria.

UNIT III WORKING CONDITIONS 9
Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9
Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire

protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT V WORKING AT HEIGHTS 9

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

TOTAL PERIODS: 45

COURSE OUTCOMES

On completion of the course the student will be able to

CO1:Understand the effect of fire on materials used for construction

CO2:Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

CO3:To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

CO4:To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

CO5:Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

TEXT BOOKS

1. Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975
2. John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

REFERENCES:

1. Smith, E.E. and Harmathy, T.Z. (Editors),"Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A,1979.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
3. Jain, V.K,"Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi,2010. 4. Hazop&Hazan,"Identifying and Assessing Process Industry Hazards", Fourth Edition ,1999
4. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-
2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-
4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-
AVg.	1.3	-	1.75	-	-	1	1.3	1		1	-	1	-	-	-

1-Low,2-Medium,3-High,"-"-no correlation

OML351 INTRODUCTION TO NON-DESTRUCTIVE TESTING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

UNIT I INTRODUCTION TO NDT & VISUAL TESTING 9

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING 9

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

UNIT III EDDY CURRENT TESTING & THERMOGRAPHY 9

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

UNIT IV ULTRASONIC TESTING & AET 9

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

UNIT V RADIOGRAPHY TESTING 9

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.

4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

TEXT BOOKS:

1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

REFERENCES:

1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John,"Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, “Handbook of Nondestructive Evaluation”, Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

CO’s, PO’s & PSO’s MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	2	2	2	3			2	2				2	1	2	
C02	3	1	2	2			2	2				2	2	2	1
C03	3	2	1	2			2	2				2	2	2	
CO4	3	1	2	2			2	2				2	2	2	2
CO5	3	2	2	2			2	2				2	2	2	1
Avg	2.8	1.6	1.8	2.2			2	2				2	1.8	2	1.3

OMR351	MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

UNIT – I INTRODUCTION AND SENSORS 9

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

UNIT – II 8085 MICROPROCESSOR 9

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Select sensors to develop mechatronics systems.

CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

TEXT BOOKS

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	3		2						2	3	2	3
CO2	3	2	1	3		2						2	3	2	3
CO3	3	2	1	3		2						2	3	2	3
CO4	3	2	1	3		2						2	3	2	3
CO5	3	2	1	3		2						2	3	2	3
CO/PO & PSO Average	3	2	1	3		2						2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

ORA351 FOUNDATION OF ROBOTICS

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES:

1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4. To familiarize students with the various Programming and Machine Vision application in robots.
5. To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

UNIT – I FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

UNIT – II ROBOT KINEMATICS 9

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

UNIT – IV SENSORS IN ROBOTICS 9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

UNIT – V PROGRAMMING AND APPLICATIONS OF ROBOT 9

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course, students will be able to:
CO1: Interpret the features of robots and technology involved in the control.
CO2: Apply the basic engineering knowledge and laws for the design of robotics.
CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.
CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.
CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

Mapping of COs with POs and PSOs															
COs/POs& PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1								1			3
CO2	3	2	1	1								1			3
CO3	3	2	1	1								1			3
CO4	3	2	1	1								1			3
CO5	3	2	1	1								1			3
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Ganesh.S.Hedge,”A textbook of Industrial Robotics”, Lakshmi Publications, 2006.
2. Mikell.P.Groover , “Industrial Robotics – Technology, Programming and applications” McGraw Hill 2^{ND} edition 2012.

REFERENCES:

1. Fu K.S. Gonalz R.C. and ice C.S.G.”Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill book co. 2007.
2. YoramKoren, “Robotics for Engineers”, McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill 2005.
4. John. J.Craig, “Introduction to Robotics: Mechanics and Control” 2nd Edition, 2002.
5. Jazar, “Theory of Applied Robotics: Kinematics, Dynamics and Control”, Springer India reprint, 2010.

OAE352 FUNDAMENTALS OF AERONAUTICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

UNIT I HISTORY OF FLIGHT 8

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 10

Different types of flight vehicles, classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

UNIT III BASICS OF AERODYNAMICS 9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton’s Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

UNIT IV BASICS OF AIRCRAFT STRUCTURES 9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke’s law- stress-strain diagrams-elastic constants-Factor of Safety.

UNIT V BASICS OF PROPULSION 9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL : 45 PERIODS

OUTCOMES:

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. . E Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAAEducation Series, 2004.

REFERENCE

1. SADHU SINGH, “INTERNAL COMBUSTION ENGINES AND GAS TURBINE”-, SS Kataraia & sons, 2015
2. KERMODE , “FLIGHT WITHOUT FORMULAE”, -, Pitman; 4th Revised edition 1989

OGI351 REMOTE SENSING CONCEPTS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck‘s law, Wien’s Displacement Law, Stefan’s Boltzmann law, Kirchoff‘s law – Radiation sources: active & passive - Radiation Quantities

UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

UNIT III ORBITS AND PLATFORMS 9

Motions of planets and satellites – Newton‘s law of gravitation - Gravitational field and potential - Escape velocity - Kepler‘s law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

UNIT IV SENSING TECHNIQUES 9

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

UNIT V DATA PRODUCTS AND INTERPRETATION 9

Photographic and digital products – Types, levels and open source satellite data products –- selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1 Understand the concepts and laws related to remote sensing
CO 2 Understand the interaction of electromagnetic radiation with atmosphere and earth material
CO 3 Acquire knowledge about satellite orbits and different types of satellites
CO 4 Understand the different types of remote sensors
CO 5 Gain knowledge about the concepts of interpretation of satellite imagery

TEXTBOOKS:

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

REFERENCES:

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

CO-PO MAPPING

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions				3	3	3
PO4	Conduct Investigations of Complex Problems				3	3	3
PO5	Modern Tool Usage				3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

OAI351 URBAN AGRICULTURE L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

UNIT I INTRODUCTION 9

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

UNIT II VERTICAL FARMING 9

Vertical farming- types, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

UNIT III SOIL LESS CULTIVATION 9

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

UNIT IV MODERN CONCEPTS 9

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

UNIT V WASTE MANAGEMENT 9

Concept, scope and maintenance of waste management- **recycle of organic waste, garden wastes- solid waste management-scope,** microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

TEXT BOOKS:

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

REFERENCES:

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

CO-PO MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	2	1
PO2	Problem Analysis	1	1	1	1	1	2
PO3	Design/ Development of Solutions	1	2	1	1	3	2
PO4	Conduct Investigations of Complex Problems	1	1	2	2	1	1
PO5	Modern Tool Usage	1	2	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	2	1	1	2	1
PO8	Ethics	2	1	1	1	2	1
PO9	Individual and team work:	1	1	2	1	1	1
PO10	Communication	1	2	1	1	2	1
PO11	Project management and finance	1	1	1	1	1	2
PO12	Life-long learning:	1	2	1	1	3	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	2	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

OEE352 ELECTRIC VEHICLE TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

UNIT I ROTATING POWER CONVERTERS 9

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

UNIT II STATIC POWER CONVERTERS 9

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES 9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the principles of conventional and special electrical machines.
CO2: Acquired the concepts of power devices and power converters
CO3: Able to understand the control for DC and AC drive systems.
CO4: Learned the electric vehicle architecture and power train components.
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
Avg	3	2	2	3	3	1	2		3		2		3	3	3

REFERENCES:

1 Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.
4 Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
5 Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2021.
6 Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017
7 James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, Wiley, 2012

OEI353 INTRODUCTION TO PLC PROGRAMMING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

UNIT I INTRODUCTION TO PLC 9

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

UNIT II PLC INSTRUCTIONS 9

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)-Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

UNIT III PLC PROGRAMMING 9

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

UNIT IV COMMUNICATION OF PLC AND SCADA 9

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

UNIT V CASE STUDIES 9

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

COURSE OUTCOMES:

CO1 Know the basic requirement of a PLC input/output devices and architecture. (L1)
CO2 Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)
CO3 Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
CO4 Able to develop a PLC logic for a specific application on real world problem. (L5)
CO5 Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

TEXT BOOKS:

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

REFERENCES:

1. MadhuchanndMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

List of Open Source Software/ Learning website:

1. https://nptel.ac.in/courses/108105063
2. https://www.electrical4u.com/industrial-automation/
3. **https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf**
4. https://www.electrical4u.com/industrial-automation/

MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

PO,PSO / CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1					1		1					
CO2	3	3	2					1		1	2				2
CO3	3	3	3	3	1			1		1					
CO4	3	3		3	3			1		1			3	3	
CO5	3	3	3	2	1			1		1			3	3	3
Avg	3	2.9	2.25	2.6	1.6			1		1			3	3	2.9

OFD352 TRADITIONAL INDIAN FOODS **L T P C**
3 0 0 3

OBJECTIVE:

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

UNIT III TRADITIONAL FOOD PATTERNS 9

Typical breakfast, meal and snack foods of different regions of India.Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods,pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

UNIT V HEALTH ASPECTS OF TRADIONAL FOODS 9

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1To understand the historical and traditional perspective of foods and food habits

CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

TEXT BOOKS:

1. Sen, Colleen Taylor "Food Culture in India" Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

OFD353 INTRODUCTION TO FOOD PROCESSING L T P C
3 0 0 3

OBJECTIVE:

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

UNIT II METHODS OF FOOD HANDLING AND STORAGE 9

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

UNIT III LARGE-SCALE FOOD PROCESSING 12

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

UNIT V FOOD HYGIENE 9

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course the students are expected to

CO1 Be aware of the different methods applied to processing foods.

CO2 Be able to understand the significance of food processing and the role of foodand beverage industries in the supply of foods.

TEXT BOOKS/REFERENCES:

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

OPY352 IPR FOR PHARMA INDUSTRY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

UNIT II PATENTS 9

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

TOTAL:45 PERIODS

TEXT BOOKS:

1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, "Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice", 2015.

REFERENCES:

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

Course Outcome

The student will be able to

C1 Understand and differentiate the categories of intellectual property rights.
C2 Describe about patents and procedure for obtaining patents.
C3 Distinguish plant variety, traditional knowledge and geographical indications under IPR.
C4 Provide the information about the different enforcements and practical aspects involved in protection of IPR.
C5 Provide different organizations role and responsibilities in the protection of IPR in the international level.
C6 Understand the interrelationships between different Intellectual Property Rights on International Society

CO – PO MAPPING												
IPR FOR PHARMA INDUSTRY												
	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO 12
C1	3	3		2					2	2		
C2		3	3				2	2				
C3	3	3					2	2				1
C4					2		3	3		2	2	
C5		3					3			2		1
C6	3	2				2	2					2

OTT351 BASICS OF TEXTILE FINISHING L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

UNIT I RESIN FINISHING 9

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

UNIT II FLAME PROOF & WATERPROOF 9

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

UNIT III SOIL RELEASE AND ANTISTATIC FINISHES 9

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

UNIT IV MECHANICAL FINISHES 9

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

UNIT V STIFFENING AND SOFTENING 9

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to Understand the

CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

TEXT BOOKS:

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., “Textile colouration and finishing”, Carolina Academic Press., U.K, ISBN: 0890898855.2004.

REFERENCES:

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY L T P C
3 0 0 3

OBJECTIVES:

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

UNIT I INTRODUCTION 9

Scope of industrial engineering in apparel Industry, role of industrial engineers.

Productivity: Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

UNIT II WORK STUDY 9

Definition, Purpose, Basic procedure and techniques of work-study.

Work environment – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

Material Handling – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

UNIT III METHOD STUDY 9

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

MOTION STUDY: Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

UNIT IV WORK MEASUREMENT 9

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

UNIT V WORK STUDY APPLICATION 9

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

TOTAL: 45 PERIODS

OUTCOMES:

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity

CO2: Method study

CO3: Motion analysis

CO4: Work measurement and SAM

CO5: Ergonomics and its application to garment industry

TEXTBOOKS:

1. George Kanwaty, “Introduction to Work Study “, ILO, Geneva, 1996, ISBN: 9221071081 |ISBN-13: 9789221071082
2. Enrick N. L., “Time study manual for Textile industry”, Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., “Industrial Engineering and Management”, Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

REFERENCES

1. Norberd Lloyd Enrick., “Industrial Engineering Manual for Textile Industry”, Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., “Introduction to Clothing Production Management”, Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., “Ergonomics in the garment industry”, Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, “Managing Productivity in Apparel Industry “CBS Publishers & Distributors, 2008

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Fundamental concepts of industrial Engineering and productivity	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	Method study	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	Motion analysis	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	Work measurement and SAM	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	Ergonomics and its application to garment industry	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
Overall CO		1.2	2	3	3	2	1	1.2	2	2	1	2.4	2	1	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OTT353 BASICS OF TEXTILE MANUFACTURE **L T P C**
3 0 0 3

OBJECTIVES:

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

UNIT I NATURAL FIBRES 9

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

UNIT II REGENERATED AND SYNTHETIC FIBRES 9

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

UNIT III BASICS OF SPINNING 9

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

UNIT IV BASICS OF WEAVING 9

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

UNIT V BASICS OF KNITTING AND NONWOVEN 9

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres

CO2: Regenerated and synthetic fibres

CO3: Yarn spinning

CO4: Weaving

CO5: Knitting and nonwoven

TEXTBOOKS

1. Mishra S. P. , "A Text Book of Fibre Science and Technology", New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., "Principles of Weaving", The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., "Knitting Technology", III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

REFERENCES:

1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., "Clothing Technology: From Fibre to Fabric", Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., "Motivate Series-Textiles", Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., "The Technology of Clothing Manufacture" Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., "The Rieter Manual of Spinning, Vol.1", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., "The Rieter Manual of Spinning, Vol.2", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., "The Rieter Manual of Spinning, Vol.1-3", Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., "Weaving: Machines, Mechanisms, Management", Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., "Textile Science", CBS Publishers and distributors, 1987, ISBN 0582685958

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
Overall CO		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPT351 BASICS OF PLASTICS PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

UNIT I INTRODUCTION TO PLASTICS PROCESSING 9

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

UNIT II EXTRUSION 9

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

UNIT III INJECTION MOLDING 9

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

UNIT IV COMPRESSION AND TRANSFER MOLDING 9

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould-positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

UNIT V BLOW MOLDING, THERMOFORMING AND CASTING 9

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

TOTAL HOURS: 45

COURSE OUTCOMES

- Ability to find out the correlation between various processing techniques with product properties.

- Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
- Acquire knowledge on additives for plastic compounding and methods employed for the same
- Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
- Select an appropriate processing technique for the production of a plastic product

REFERENCES

1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

OEC351	**SIGNALS AND SYSTEMS**	**L T P C**
		3 0 0 3

COURSE OBJECTIVES :

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1:determine if a given system is linear/causal/stable

CO2: determine the frequency components present in a deterministic signal

CO3:characterize continuous LTI systems in the time domain and frequency domain

CO4:characterize discrete LTI systems in the time domain and frequency domain

CO5:compute the output of an LTI system in the time and frequency domains

TEXT BOOKS:

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

REFERENCES :

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	-	3	-	3	2	-	-	-	-		3	-	-	1
2	3	-	3	-	-	2	-	-	-	-		3	-	3	-
3	3	3	-	-	3	2	-	-	-	-		3	2	-	-
4	3	3	-	-	3	2	-	-	-	-		3	-	3	1
5	3	3	-	3	3	2	-	-	-	-		3	-	3	1
C	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**	**1**

OEC352 FUNDAMENTALS Of ELECTRONIC DEVICES AND CIRCUITS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

UNIT I SEMICONDUCTOR DEVICES 9

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

UNIT II AMPLIFIERS 9

Load line, operating point, biasing methods for BJT and MOSFET**,** BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

At the end of the course the students will be able to

CO1: Explain the structure and working operation of basic electronic devices.

CO2: Design and analyze amplifiers.

CO3: Analyze frequency response of BJT and MOSFET amplifiers

CO4: Design and analyze feedback amplifiers and oscillator principles.

CO5: Design and analyze power amplifiers and supply circuits

TEXT BOOKS :

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

REFERENCES :

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1
CO	**3**	**3**	**3**	**3**	**2**	**2**	-	-	-	-	-	**1**	**2**	**1**	**1**

CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification

- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I BASICS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to:

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford,

2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	1						1		1			
2	3	2	3	1						1		1			
3	3	2	3	1	1			1	1	1		1			
4	3	2	3	1	1			1	1	1		1			
5	3	2	3	1	1			1	1	1		1			
AVg.															

CBM333 ASSISTIVE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
The student should be made to:
- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

UNIT I CARDIAC ASSIST DEVICES 9
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

UNIT II HEMODIALYSERS 9
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III HEARING AIDS 9
Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

UNIT IV PROSTHETIC AND ORTHODIC DEVICES 9
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

UNIT V RECENT TRENDS 9
Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

TOTAL : 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.
CO2: Describe the underlying principles of hemodialyzer machine.
CO3: Indicate the methodologies to assess the hearing loss.
CO4: Evaluate the types of assistive devices for mobilization.
CO5: Explain about TENS and biofeedback system.

TEXT BOOKS

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

REFERENCES

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

CO's	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1										
2	3	1	1	1	1										
3	3	1	1	1	1										
4	3	1	1	1	1										
5	3	1	1	1	1										
AVg.															

OMA352 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

OBJECTIVES:

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

UNIT I LINEAR PROGRAMMING 9

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS 9

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

UNIT III INTEGER PROGRAMMING 9

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

UNIT IV DYNAMIC PROGRAMMING PROBLEMS 9

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

UNIT V NON - LINEAR PROGRAMMING PROBLEMS 9

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

TOTAL: 45 PERIODS

OUTCOMES :

At the end of the course, students will be able to

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- solve the integer programming problems using various methods.
- conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- determine the optimum solution for non linear programming problems.

TEXT BOOKS:

1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.

REFERENCES :

1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " (Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.L.td, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1	0.8	0	0	0	0	2	0	0	2	-	-	-

OMA353 ALGEBRA AND NUMBER THEORY L T P C
3 0 0 3

OBJECTIVES :

To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.

- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

UNIT I GROUPS AND RINGS 9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.
Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

UNIT II FINITE FIELDS AND POLYNOMIALS 9

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS 9

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES 9

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS 9

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

TOTAL: 45 PERIODS

OUTCOMES :

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

TEXT BOOKS :

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.

REFERENCES:

1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition , 2006.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
CO2	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
CO3	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
CO4	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
CO5	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
Avg	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.6	-	-	-

OMA354 **LINEAR ALGEBRA** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS 9

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

UNIT II VECTOR SPACES 9

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

UNIT III LINEAR TRANSFORMATION 9

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

UNIT IV INNER PRODUCT SPACES 9

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION 9

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

TEXT BOOKS

1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5th Edition,2019.

REFERENCES

1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7th Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4th Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	2.8	2	2	1	1	1	1	3	-	-	-

OBT352 BASICS OF MICROBIAL TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVE:

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

UNIT I BASICS OF MICROBES AND ITS TYPES 9

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

UNIT II MICROBIAL TECHNIQUES 9

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III PATHOGENIC MICROBES 9

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

UNIT IV BENEFICIAL MICROBES 9

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

UNIT V PRODUCTS FROM MICROBES 9

Fermentedproducts – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of the course the students will be able to

1. Microbes and their types
2. Cultivation of microbes
3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

OBT353 **BASICS OF BIOMOLECULES** **L T P C**
3 0 0 3

OBJECTIVES:

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

UNIT I CARBOHYDRATES 9

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

UNIT II LIPID AND FATTY ACIDS 9

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

UNIT III AMINO ACIDS AND PROTEIN. 9

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denauration – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein.Biological function of protein.

UNIT IV NUCLEIC ACIDS 9

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & amp; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature· DNA double helix (Watson and crick) model, types of DNA, RNA.

UNIT V VITAMINS AND HORMONES 9

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin.Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses ofvitamins and hormones.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

TEXT BOOKS

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, “Biochemistry” 3rd Rev. Edition, Books & Allied (P) Ltd., 2006. 3. Rastogi, S.C. “Biochemistry” 2nd Edition, Tata McGraw-Hill, 2003.
3. Conn, E.E., etal., “Outlines of Biochemistry” 5th Edition, John Wiley & Sons, 1987.
4. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi.pp 693. John Wiley and Sons, New York. 1987.

REFERENCES

1. Berg, Jeremy M. et al. “Biochemsitry”, 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., etal “Harper’s Illustrated Biochemistry”, 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., “Biochemistry”, 4th Edition, John Wiley & Sons Inc., 2010.

OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY L T P C
3 0 0 3

OBJECTIVES:
- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

UNIT I INTRODUCTION TO CELL 9
Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria,cyanobacteria, mycoplasma and prions.

UNIT II CELL ORGANELLES 9
Molecular organisation, biogenesis and functin Mitochondria, endoplasmic reticulam, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

UNIT III BIO-MEMBRANE TRANSPORT 9
Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane's-fick's law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transportmechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

UNIT IV CELL CYCLE 9
Cell cycle- Cell division by mitosis and meosis, Comparision of meosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

UNIT V CENTRAL DOGMA 9
Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

TOTAL: 45 PERIODS

OUTCOMES:
- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

TEXTBOOKS:
1. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8th Edition, Oxford University Press, 2018
2. Friefelder, David. "Molecular Biology." Narosa Publications, 1999
3. Weaver, Robert F. "Molecular Biology" IInd Edition, Tata McGraw-Hill, 2003.

REFERENCES:
1. Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. BBecker, W.M. etal., "The World of the Cell", 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Recee and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce etal., "Essential Cell Biology", 4th Edition, W.W. Norton, 2013.

OPEN ELECTIVE IV

OHS352 **PROJECT REPORT WRITING** **L T P C**
3 0 0 3

COURSE OBJECTIVE

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

UNITI **9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

UNIT II **9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

UNIT III **9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

UNIT IV **9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

UNIT V **9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL:45 PERIODS

OUTCOMES

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
AVg.	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

REFERENCES

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
   Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

OMA355 ADVANCED NUMERICAL METHODS **L T P C**
3 0 0 3

OBJECTIVE:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

UNIT II INTERPOLATION 9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to:
CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;
CO2: understand the interpolation theory;
CO3: understand the concepts of numerical methods for ordinary differential equations;
CO4: demonstrate the understandings of common numerical methods for elliptic equations;
CO5: understand the concepts of numerical methods for time dependent partial differential equations

TEXT BOOKS :

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

REFERENCES:

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., “Numerical Methods for Engineers”,4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., “Introductory Methods of Numerical Analysis”, 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

CO’s- PO’s & PSO’s MAPPING

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
Avg	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

OMA356 RANDOM PROCESSES **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

UNIT I RANDOM VARIABLES 9

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

UNIT II RANDOM PROCESSES 9

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

UNIT III SPECIAL RANDOM PROCESSES 9

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 9

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

TOTAL: 45 PERIODS

OUTCOMES

Upon successful completion of the course, students should be able to:

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

TEXT BOOKS

1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.

REFERENCES

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
Avg	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

OMA357 QUEUEING AND RELIABILITY MODELLING L T P C
3 0 0 3

OBJECTIVES:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.

- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

UNIT I RANDOM PROCESSES 9

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

UNIT II MARKOVIAN QUEUEING MODELS 9

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

UNIT III ADVANCED QUEUEING MODELS 9

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and $M/E_K/1$ as special cases – Series queues – Open Jackson networks.

UNIT IV SYSTEM RELIABILITY 9

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

UNIT V MAINTAINABILITY AND AVAILABILITY 9

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

TOTAL: 45 PERIODS

OUTCOMES

Upon successful completion of the course, students should be able to:

- Enable the students to apply the concept of random processes in engineering disciplines.
- Students acquire skills in analyzing various queueing models.
- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

TEXT BOOKS

1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York,2018.
2. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.

REFERENCES

1. Medhi J, "Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4. Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.

	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
Avg	3	3	1.4	0.8	0	0	0	0	2	0	0	2	-	-	-

OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVES
- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

UNIT I OVERVIEW OF IWRM 9
Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION 9
Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

UNIT III WATER ECONOMICS 9
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

UNIT IV RECENT TREANDS IN WATER MANAGEMENT 9
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

UNIT V IMPLEMENTATION OF IWRM 9
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

TOTAL: 45 PERIODS

OUTCOMES
- On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2 Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
CO3 Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO4 Illustrate the recent trends in water management.
CO5 Understand the implementation hitches and the institutional frameworks.

TEXT BOOKS

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

REFERENCES

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrm/Tutorial_text.pdf
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, https://sdgs.un.org/goals.

OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

UNIT V CONTROLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course the learners will be able :

CO 1 To understand the basics and functions of Production and Operation Management for business owners.

CO 2 To learn about the Production & Operation Systems.

CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

CO 4 To known about the Production & Operations Management Processes in organisations.

CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

REFERENCES

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.

2. Amitabh Raturi, Production and Inventory Management, , 2008.

3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

OMG355	MULTIVARIATE DATA ANALYSIS	L T P C
		3 0 0 3

OBJECTIVE:

- To know various multivariate data analysis techniques for business research.

UNIT I INTRODUCTION 9

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

UNIT II PREPARING FOR MULTIVARIATE ANALYSIS 9

Conceptualization of research model with variables, collection of data –-Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS 9

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

UNIT IV LATENT VARIABLE TECHNIQUES 9

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

UNIT V ADVANCED MULTIVARIATE TECHNIQUES 9

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

TOTAL: 45 PERIODS

OUTCOMES :

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

REFERENCES :

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

OME352 ADDITIVE MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

UNIT I INTRODUCTION 9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION 9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

UNIT III POWDER BED FUSION AND BINDER JETTING 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION 9

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY 9

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.

Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

CO3: Elaborate the process and applications of powder bed fusion and binder jetting.

CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

CO5: Acquire knowledge on sheet lamination and direct write technology.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCES:

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

CME343	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To introduce the fundamental concepts of the new product development
2 To develop material specifications, analysis and process.
3 To Learn the Feasibility Studies & reporting of new product development.
4 To study the New product qualification and Market Survey on similar products of new product development
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

UNIT – I FUNDAMENTALS OF NPD 9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT – III ESSENTIALS OF NPD 9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT – IV CRITERIONS OF NPD 9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT – V REPORTING & FORWARD-THINKING OF NPD 9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	3	1				1	1			1	1	3	2
2	1	1	3	1				1	1			1	1	3	2
3	1	1	3	1				1	1			1	1	3	2
4	1	1	3	1				1	1			1	1	3	2
5	1	1	3	1				1	1			1	1	3	2
Low (1) ; Medium (2) ; High (3)															

OME355 INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

UNIT I UI/UX 9

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and

Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

UNIT II APP DEVELOPMENT 9

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT III INDUSTRIAL DESIGN 9

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

UNIT IV MECHANICAL RAPID PROTOTYPING 9

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT V ELECTRONIC RAPID PROTOTYPING 9

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

TOTAL: 45 PERIODS

COURSE 0UTCOMES

At the end of the course, learners will be able to:

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

TEXT BOOKS

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

REFERENCES

1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4. https://help.prusa3d.com/en/categor y/prusaslicer_204

MF3010 MICRO AND PRECISION ENGINEERING LT P C
3 0 0 3

COURSE OBJECTIVES:

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.

- Learn metrology for micro system

UNIT I INTRODUCTION TO MICROSYSTEMS 9

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

UNIT III INTRODUCTION TO PRECISION ENGINEERING 9

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

UNIT IV PRECISION MACHINING PROCESSES 9

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V METROLOGY FOR MICRO SYSTEMS 9

Metrology for micro systems - Surface integrity and its characterization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of this course the students will be able to

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

TEXT BOOKS:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

REFERENCES:

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, ―Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005

OMF354 COST MANAGEMENT OF ENGINEERING PROJECTS

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT – I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

UNIT – II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT – III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT – IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT – V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO1: Understand the costing concepts and their role in decision making.
CO2: Understand the project management concepts and their various aspects in selection.
CO3: Interpret costing concepts with project execution.
CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.
CO5: Become familiar with quantitative techniques in cost management.

TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

AU3002 BATTERIES AND MANAGEMENT SYSTEM L T P C

3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

UNIT I ADVANCED BATTERIES 9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

UNIT II BATTERY PACK 9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNITIII BATTERY MODELLING 9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

UNIT IV BATTERY STATE ESTIMATION 9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of this course, students will be able to

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a BatteryModel or Simulation.
4. Estimate State-of-Charges in a Battery Pack.
5. Approach different BMS architectures during real world usage.

TEXT BOOKS

1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
2. Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

REFERENCE BOOKS

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

AU3008 SENSORS AND ACTUATORS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS 9

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TOTAL =45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of thesensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

TEXT BOOKS:

1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCES:

1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003

4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

OAS353 SPACE VEHICLES

L	T	P	C
3	0	0	3

OBJECTIVES:
- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

UNIT I FUNDAMENTAL ASPECTS 9
Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9
Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9
Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

UNIT IV THRUST VECTOR CONTROL 9
TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

UNIT V NOSE CONE CONFIGURATION 9
Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

OIM352 MANAGEMENT SCIENCE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:
Of this course are
1. To introduce fundamental concepts of management and organization to students.
2. Toi mpart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.

5. To make students familiarize with the concepts of planning process and business strategies.

UNITI INTRODUCTION TO MANAGEMENT AND ORGANISATION 9

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's TheoryXandTheoryY-HertzbergTwoFactorTheoryofMotivation-LeadershipStyles,Socialresponsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation -Departmentation and Decentralisation.

UNITII OPERATIONS AND MARKETING MANAGEMENT 9

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement - BusinessProcessReengineering(BPR)-StatisticalQualityControl:controlchartsforVariablesandAttributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.

UNITIII HUMAN RESOURCES MANAGEMENT 9

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager:Manpower planning, Recruitment, Selection, TrainingandDevelopment,WageandSalaryAdministration,Promotion,Transfer,PerformanceAppraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM)Levels.

UNITIV PROJECT MANAGEMENT 9

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis,Project Crashing (simple problems).

UNITV STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cardas Contemporary Business Strategies.

TOTAL: 45 PERIODS

OURSEOUTCOMES:

Upon completion of the course, Students will be able to

CO1:PlananorganizationalstructureforagivencontextintheorganisationtocarryoutproductionoperationsthroughWork-study.

CO2:Surveythemarkets,customersandcompetitionbetterandpricethegivenproductsappropriatey

CO3:Ensurequalityforagivenproduct or service.

CO4:Plan, schedule and control projects through PERTandCPM.

CO5:Evaluate strategyforabusiness orserviceorganisation.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			3	3	3		3	3	2			2	3	
2	3			2	3	3		2	3	2				2	
3	3			3	2	2		3	2	2					2
4	3			3	3	2		3	2	3					3
5	3			2	3	3		2	3	3			2	1	
AVg.	3			2.6	2.8	2.6		2.6	2.6	2.4			2	2	2.5

TEXTBOOKS:

1. KanishkaBedi, Production and Operations Management,OxfordUniversityPress,2007.
2. Stoner,Freeman,Gilbert, Management,6th Ed, PearsonEducation,NewDelhi,2004.
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra,2007.
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012.

REFERECES:

1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeihrich: Essentials of Management, McGrawHill, 2012.
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.
4. SamuelC.Certo:Modern Management,2012.

OIM353	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNITII WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNITIII PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

UNITIV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course,

CO1:The students can able to prepare production planning and control act work study,
CO2:The students can able to prepare product planning,
CO3:The students can able to prepare production scheduling,
CO4:The students can able to prepare Inventory Control.
CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

TEXT BOOKS:

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

REFERENCES

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			3		1				1		3		
2	3	2			3									2	
3		2			3									2	
4		2	2												
5	3	3	2											1	
AVg.	3	2.6	2		3		1				1		3	1.8	

OIE353 OPERATIONS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE:

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit , framework; Supply Chain Management

UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9

Demand Forecasting – Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivityand Methods to improve productivity.

UNIT IV MATERIALS MANAGEMENT 9

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES,Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

UNIT V SCHEDULING AND PROJECT MANAGEMENT 9

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson‟sAlgorithm – Gantt charts; personnel scheduling in services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The students will appreciate the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment.

CO2: The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.

CO3: The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.

CO4: The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.

CO5: The students will be able to apply scheduling and Lean Concepts for improving System Performance.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											2			
2		3	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
AVg.	3	2.6	3	2.6								2	2	3	3

TEXT BOOKS

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations andSupply Management, Tata McGraw Hill, 12th Edition, 2010.

2. Norman Gaither and Gregory Frazier, Operations Management, South Western CengageLearning, 2002.

REFERENCES

1. William J Stevenson, Operations Management, Tata McGraw Hill, 9th Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, HimalayaPublishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

OSF352	INDUSTRIAL HYGIENE	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

UNIT I INTRODUCTION AND SCOPE 9

Occupational Health and Environmental Safety Management - Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9

Element of training cycle, Assessment of needs.Techniques of training, design and development of training programs.Training methods and strategies types of training.Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

UNIT-V INDUSTRIAL HAZARDS 9

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

TOTAL PERIODS: 45

COURSE OUTCOMES:

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

TEXT BOOKS:

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

REFERENCES:

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2		2	-	-	-	-	-	2	-	-	-	-
2	-		2		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2		-	-	-

OSF353 CHEMICAL PROCESS SAFETY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.

- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

UNIT II CHEMICAL REACTION HAZARDS 9

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

UNIT V SAFETY AND ANALYSIS 9

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students able to

CO1 Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.

CO2 Develop thorough knowledge about safety in the operation of chemical plants.

CO3 Apply the principles of safety in the storage and handling of gases.

CO4 Identify the conditions that lead to reaction hazards and adopt measures to prevent them.

CO5 Develop thorough knowledge about

TEXT BOOK

1 David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 3rd Edition,2014

2 Maurice Jones .A,"Fire Protection Systems,2nd edition, Jones & Bartlett Publishers,2015

REFERENCES:

1. Ralph King and Ron Hirst,"King´s safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.

3. National Safety Council," Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr,"Sax´s dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety",3rd Edition, Gulf professional publishing, 2006

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
2	-			2	-	-	-	-	1	-		-	-	2	-
3	-	3		1	-	-	-	2	-	-	1	-	-	-	-
4	-	2	-		-	1	-	-	1	-		-	-	-	2
5	-	2	3		-	-	-	1	-	-	1	-	-	-	-
AVg.	2	2.5	3	1.5	-	1	-	1.5	1	-	1		2	2	2

OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the importance of various materials used in electrical, electronics and
- magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

UNIT I DIELECTRIC MATERIALS 9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT II MAGNETIC MATERIALS 9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

UNIT III SEMICONDUCTOR MATERIALS 9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS 9

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS 9

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to

1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

TEXT BOOKS:

1. Pradeep Fulay, “Electronic, Magnetic and Optical materials”, CRC Press, taylor and Francis, 2 nd illustrated edition, 2017.
2. “R K Rajput”, “A course in Electrical Engineering Materials”, Laxmi Publications, 2009.

REFERENCE BOOKS:

1. T K Basak, “A course in Electrical Engineering Materials”, New Age Science Publications, 2009
2. TTTI Madras, “Electrical Engineering Materials”, McGraw Hill Education, 2004.
3. Adrianus J. Dekker, “Electrical Engineering Materials”, PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta “A course in Electrical Engineering Materials”, Dhanpat Rai & amp; Sons, 2011.
5. C. Kittel, “Introduction to Solid State Physics”, 7th Edition, John Wiley & Sons,Singapore, (2006).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3
C01	3	2	2	3								2	2	2	1
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	1
CO4	3	2	1	2								2	2	2	2
CO5	3	2	2	2								2	2	2	1
Avg	3	1.8	1.6	2.2								2	2	2	1.2

OML353 NANOMATERIALS AND APPLICATIONS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of

engineering.

UNIT I NANOMATERIALS 9

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT III PROCESSING 9

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

UNIT IV STRUCTURAL CHARACTERISTICS 9

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

UNIT V APPLICATIONS 9

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

TEXT BOOKS:

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

REFERENCES:

1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid’ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	2	2	2	3								2	1	2	
C02	3	1	2	2								2	2	2	1
C03	3	2	1	2								2	2	2	
CO4	3	1		2								2	2	2	2
CO5	3	2	2	2								2	2	2	1

Avg	2.8	1.6	1.7	2.2								2	1.8	2	1.3

OMR353 SENSORS

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES:

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

UNIT – I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

UNIT – II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

UNIT – IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

UNIT – V SIGNAL CONDITIONING 9

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the densor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.
CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2								1	2	3	2	1
CO2	3	3	2	1	1	1					1	2	3	2	1
CO3	3	3	2	1	1	1					1	2	3	2	1
CO4	3	3	2	1	1	1					1	2	3	2	1
CO5	3	3	2	1	1	1					1	2	3	2	1
CO/PO & PSO Average	3	3	2	0.8	0.8	0.8					0.8	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

REFERENCES

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

ORA352	CONCEPTS IN MOBILE ROBOTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

UNIT – II KINEMATICS 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

UNIT – III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

UNIT – IV LOCALIZATION 9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Evaluate the appropriate mobile robots for the desired application.

CO2: Create the kinematics for given wheeled and legged robot.

CO3:Analyse the sensors for the intelligence of mobile robotics.

CO4: Create the localization strategies and mapping technique for mobile robot.

CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

TEXTBOOK

1. Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.

REFERENCES:

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

MV3501 MARINE PROPULSION L T P C
3 0 0 3

COOURSE OBJECTIVES:

- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment’s
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- To impart knowledge on ship rudder and its types

UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

UNIT III SHIPS SPEED AND ITS PERFORMANCE 9

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation’s, ship turning radius.

UNIT IV BASICS OF PROPELLER 9

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

UNIT V BASICS OF RUDDER 9

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:
CO1: Explain the basics of propulsion system and ship dynamic movements
CO2: Familiarize with various components assisting ship stabilization.
CO3: Demonstrate the performance of the ship.
CO4: Classify the Propeller and its types, Materials etc.
CO5: Categories the Rudder and its types, design criteria of rudder.

TEXT BOOKS:

1. GP. Ghose, “Basic Ship propulsion”,2015
2. E.A. Stokoe “Reeds Ship construction for marine engineers”, Vol. 5,2010
3. E.A. Stokoe, “Reeds Naval architecture for the marine engineers”,4th Edition,2009

REFERENCES BOOKS:

1. DJ Eyers and GJ Bruse, “Ship Construction”, 7th Edition, 2006.
2. KJ Rawson and EC Tupper, “Basic Ship theory I” Vol. 1,5th Edition,2001.

MAPPING OF COS AND POS:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1	1	1	1						1	1		1		1
2	1	1	1											1		1
3	1			1	1				1	1	1		1	1		1
4	1		1	1										1		1
5	1		1	1										1		1
Avg	5/5=1	2/2=1	4/4=1	4/4=1	2/2=1				1/1=1	1/1=1	2/2=1	1/1=1	1/1=1	5/5=1		5/5=1

OMV351 **MARINE MERCHANT VESSELS** **LT P C**
3 0 0 3

OBJECTIVES:

At the end of the course, students are expected to acquire

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

UNIT I INTRODUCTION TO HYDROSTATICS 9

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

UNIT II TYPES OF SHIP 10

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gascarriers - Chemical tankers - Passenger ships

UNIT III SHIPBUILDING MATERIALS 9

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

UNIT IV MARINE PROPELLER AND RUDDER 8

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY 9

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships) , **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students would

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

TEXT BOOKS:

1. D.J.Eyres, “Ship Constructions”, Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006
3. EA Stokoe, E.A, “Naval Architecture for Marine Engineers”, Vol.4, Reeds Publications,2000

REFERENCES:

1. Kemp & Young “Ship Construction Sketches & Notes”, Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

OMV352 ELEMENTS OF MARINE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
At the end of the course, students are expected to

- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system
- Have acquired basics of Marine Auxiliary boiler system
- Be aware of ship propellers and steering system

UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS 9
Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

UNIT II MARINE PROPULSION MACHINERY SYSTEM 9
Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9
Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

UNIT IV MARINE BOILER SYSTEM 9
Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9
Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students should able to,

- Distinguish the role of various marine machinery systems
- Relate the components of marine propulsion machinery system
- Explain the importance of marine auxiliary machinery system
- Acquire knowledge of marine boiler system
- Understand the importance of ship propellors and steering system

TEXT BOOKS:

1. Taylor, "Introduction to Marine engineering", Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, "Basic Marine Engineering", Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, " Text book on Marine Engineering", Eswar Press, Chennai, 2018

REFERENCES:

1. Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015

CRA332 DRONE TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of drone concepts
2. To learn and understand the fundaments of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Createthe programs for various drones

CO-PO MAPPING:

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3	1	3	2						1	2	1	3
CO2	1	2	3	1	3	2						1	2	1	3
CO3	1	2	3	1	3	2						1	2	1	3
CO4	1	2	3	1	3	2						1	2	1	3
CO5	1	2	3	1	3	2						1	2	1	3

CO/PO & PSO Average	1	2	3	1	3	2						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

OGI352 GEOGRAPHIC INFORMATION SYSTEM L T P C
3 0 0 3

OBJECTIVES:

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

UNIT I FUNDAMENTALS OF GIS 9

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

UNIT II SPATIAL DATA MODELS 9

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

UNIT III DATA INPUT AND TOPOLOGY 9

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

UNIT IV DATA QUALITY AND STANDARDS 9

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

UNIT V DATA MANAGEMENT AND OUTPUT 9

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1 Have basic idea about the fundamentals of GIS.
CO2 Understand the types of data models.

CO3 Get knowledge about data input and topology
CO4 Gain knowledge on data quality and standards
CO5 Understand data management functions and data output

TEXTBOOKS:
1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

REFERENCES:
1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM

PO	Graduate Attribute	Course Outcome					Average
		CO1	CO2	CO3	CO4	CO5	
PO1	Engineering Knowledge	3	3	3	3	3	3
PO2	Problem Analysis				3	3	3
PO3	Design/Development of Solutions			3	3	3	3
PO4	Conduct Investigations of Complex Problems			3	3	3	3
PO5	Modern Tool Usage		3		3	3	3
PO6	The Engineer and Society						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

OAI352 AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT **L T P C**
3 0 0 3

OBJECTIVES
- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9
Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE 9

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE 9

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs-Economic system and its implication for decision making by individual entrepreneurs.

UNITV ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis-Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private
partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- Judge about agricultural finance, banking and cooperation
- Evaluate basic concepts, principles and functions of financial management
- Improve the skills on basic banking and insurance schemes available to customers
- Analyze various financial data for efficient farm management
- Identify the financial institutions

TEXT BOOKS

1. Joseph L. Massie, 1995, “Essentials of Management”, prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.

REFERENCES

1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

CO-PO MAPPING

PO/PSO		CO1	CO2	CO3	CO4	CO5	Overall correlation of COs with POs
PO1	Engineering Knowledge	1	2	1	1	1	2
PO2	Problem Analysis	2	1	1	1	2	1
PO3	Design/ Development of Solutions	1	1	1	2	1	2
PO4	Conduct Investigations of Complex Problems	1	1	2	1	1	1
PO5	Modern Tool Usage	2	1	1	1	1	2
PO6	The Engineer and Society	1	2	1	2	1	1
PO7	Environment and sustainability	1	1	2	1	1	1
PO8	Ethics	1	2	1	1	1	1
PO9	Individual and team work:	1	1	1	2	1	1
PO10	Communication	1	1	1	1	2	1
PO11	Project management and finance	1	1	2	1	1	1
PO12	Life-long learning:	1	2	1	1	1	2
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	1	1
PSO2	To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.	1	1	2	1	1	1
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	1	2	1

OEE353 INTRODUCTION TO CONTROL SYSTEMS **L T P C**
3 0 0 3

OBJECTIVES

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

UNIT I MATHEMATICAL MODELS OF PHYSICALSYSTEMS 9

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUSTECHNIQUE 9

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

UNIT III FREQUENCY RESPONSE ANALYSIS 9

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

UNIT IV STABILITY CONCEPTS & ANALYSIS 9

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion — Stability from Bode plot — Relative stability from Nyquist & Bode — Closed loop frequency response.

UNITV STATE VARIABLE ANALYSIS 9

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

TOTAL : 45 PERIODS

OUTCOMES:

Ability to

CO1: Design the basic mathematical model of physical System.

CO2: Analyze the time response analysis and techniques.

CO3: Analyze the transfer function from different plots.

CO4: Apply the stability concept in various criterion.

CO5: Assess the state models for linear and continuous Systems.

TEXTBOOKS

1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

REFERENCES

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System AnalysisandDesign, 5th Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S.Janardhanan, Modern Control, Cengage Learning, First Impression2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							2	3	3	3
CO2	3	3	2	3	1								3	3	3
CO3	3	3	3	2	2								3	3	3
CO4	3	3	3	2	2							2	3	3	3
CO5	3	3	3	1	1							1	3	3	3
													3	3	3

OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS **LT P C**
3 0 0 3

COURSE OBJECTIVES:

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

UNIT I INTRODUCTION 9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

UNIT II AUTOMATION COMPONENTS 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT V DISTRIBUTED CONTROL SYSTEM 9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

COURSE OUTCOMES:

Students able to

CO1 Design a signal conditioning circuits for various application (L3).

CO2 Acquire a detail knowledge on data acquisition system interface and DCS system (L2).

CO3 Understand the basics and Importance of communication buses in applied automation Engineering (L2).

CO4 Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)

CO5 Able to develop a PLC logic for a specific application on real world problem. (L5)

TEXT BOOKS:

1. S.K.Singh, “Industrial Instrumentation”, Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000.

REFERENCES:

1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,“Programmable Logic Controller”, CeneageLearning, 3 rd Edition,2005.

List of Open Source Software/ Learning website:

1. https://archive.nptel.ac.in/courses/108/105/108105062/
2. https://nptel.ac.in/courses/108105063
3. https://www.electrical4u.com/industrial-automation/
4. https://realpars.com/what-is-industrial-automation/
5. https://automationforum.co/what-is-industrial-automation-2/

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	1	1	-	1	-	1	-	1	1	-	1
CO2	3	`1	1	-	1	-	-	1	-	1	-	-	1	-	1
CO3	3	-	1	-	1	-	-	1	-	1	-	-	1	-	1
CO4	3	3	3	3	1			1		1			1		1
CO5	3	3	3	3	1	1		1		1			1		1
AVg.	3	2.25	2	2.6	1	1	-	1	-	1	-	-	1	-	1

OFD354 FUNDAMENTALS OF FOOD ENGINEERING L T P C
3 0 0 3

OBJECTIVES

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

UNIT I 9

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

UNIT II 9

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

UNIT III 9

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

UNIT IV 9

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

UNIT V 9

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

TEXTBOOKS:

1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Intitute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

OFD355 FOOD SAFETY AND QUALITY REGULATIONS L T P C
3 0 0 3

OBJECTIVES:

• To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
• To help become skilled in systems for food safety surveillance
• To be aware of the regulatory and statutory bodies in India and the world
• To ensure processed food meets global standards

UNIT I 10

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

UNIT II 8

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

UNIT III 9

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

UNIT IV **9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

UNIT V **9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

REFERENCES:

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

OPY353 **NUTRACEUTICALS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

UNIT I INTRODUCTION AND SIGNIFICANCE **6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS **11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY **11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

UNIT IV ROLE IN HEALTH AND DISEASE **11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

UNIT V SAFETY ISSUES 6

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

TOTAL: 45 PERIODS

COURSE OUTCOME

CO 1 acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.

CO 2 acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes

CO 3 attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.

CO 4 distinguish the various *In vitro* and *In vivo* assessment of Antioxidant activity of compounds from plant sources.

CO 5 gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.

CO 6 Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

TEXT BOOKS:

1. Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.

REFERENCES:

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

CO – PO MAPPING												
NUTRACEUTICALS												
Course outcome	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO10	PO11	PO12
CO 1	3											1
CO 2	3											1
CO 3	3					2						
CO 4	3											
CO 5	3					2						1
CO 6	3							2				1

OTT354 **BASICS OF DYEING AND PRINTING** **L T P C**
3 0 0 3

OBJECTIVE:

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

UNIT I INTRODUCTIO 9

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

UNIT II PRE TREATMENT 9

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

UNIT III DYEING 9

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

UNIT IV PRINTING 9

Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

UNIT V MACHINERIES 9

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to Understand the
CO1: Basics of grey fabric
CO2: Basics of pre treatment
CO3: Concept of Dyeing
CO4: Concept of Printing
CO5: Machinery in processing industry

TEXT BOOKS:

1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. “Technology of Textile Processing Vol. IV” 1998, Sevak Publications, Mumbai.

REFERENCES:

1. Trotman E. R., “Dyeing and Chemical Technology of Textile Fibres”, Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., “Textile dyeing”, Wood head publishing India, 2018
3. Mathews Kolanjikombil., ”Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics”, Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	Classification of fibres and production of natural fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2.	Regenerated and synthetic fibres	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3.	Yarn spinning	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4.	Weaving	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5.	Knitting and nonwoven	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
Overall CO		-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FT3201 FIBRE SCIENCE **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To enable the students to learn about the types of fibre and its properties

UNIT I INTRODUCTION TO TEXTILE FIBRES 9

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

UNIT II REGENERATED FIBRES 9

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

UNIT III SYNTHEITC FIBRES 9

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

UNIT IV SPECIALITY FIBRES 9

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

UNIT V FUNCTIONAL SPECIALITY FIBRES 9

Properties and end uses : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

TEXT BOOKS:

1. Morton W. E., and Hearle J. W. S., "Physical Properties of Textile Fibres", The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., "Physical Methods of Investigation of Textiles", Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., "Advances in Fibre Science", The Textile Institute,1992, ISBN: 1870812379

REFERENCES:

1. Meredith R., "Mechanical Properties of Textile Fibres", North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., "Atlas of Fibre Fracture and Damage to Textiles", The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.)., "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

OTT355 GARMENT MANUFACTURING TECHNOLOGY **L T P C**
3 0 0 3

OBJECTIVE:

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9

Garment pressing – categories and equipment, packing; care 330abelling of apparels

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to Understand

CO1: Pattern making, marker planning, cutting

CO2: Types of seams, stitches and functions of needles

CO3: Components and trims used in garment

CO4: Garment inspection and dimensional changes

CO5: Garment pressing, packing and careabelling

TEXT BOOKS:

1. Carr H., and Latham B., “The Technology of Clothing Manufacture”, Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

REFERENCES:

1. Winifred Aldrich., “Metric Pattern Cutting”, Blackwell Science Ltd., Oxford, 1994
2. Peggal H., “The Complete Dress Maker”, Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., “Sewing Thread”, NITRA, 1994
4. Ruth Glock, Grace I. Kunz, “Apparel Manufacturing”, Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, “An Introduction to Quality Control for the Apparel Industry”, J.S.N. Internationals, 1992.

CO’s	PO’s												PSO’s			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1	3
2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1	2
3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1	3
4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1	3
5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1	2
Avg	1.6	1.2	1	0.8	1.4	0.8	1.4	1	0.2	1.8	2.4	1	1.8	2.6	1	2.6

OPE353 INDUSTRIAL SAFETY **L T P C**
3 0 0 3

OBJECTIVES:

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

UNIT I INTRODUCTION 9

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

UNIT IV HAZARDS AND RISK MANAGEMENT 9

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of this course, the student is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

OPT352 PLASTIC MATERIALS FOR ENGINEERS L T P C

3 0 0 3

COURSE OBJECTIVES

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

UNIT I INTRODUCTION TO PLASTIC MATERIALS 9

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

UNIT III THERMOSETTING PLASTICS 9

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

TOTAL : 45 PERIODS

COURSE OUTCOMES

- To study the importance, advantages and classification of plastic materials
- Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
- To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
- Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
- To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

REFERENCES

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8th Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7th Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4th Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3rd Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2nd Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

OPT353 PROPERTIES AND TESTING OF PLASTICS L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

UNIT II MECHANICAL PROPERTIES 9

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

UNIT III THERMAL RHEOLOGICAL PROPERTIES 9

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence**.**

UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

REFERENCES

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2^{nd} Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3^{rd} Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

OEC353 VLSI DESIGN L T P C
3 0 0 3

OBJECTIVES:

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

UNIT I MOS TRANSISTOR PRINCIPLES 9

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

UNIT IV INTERCONNECT, MEMORY ARCHITECTURE 9

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS 9

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

TOTAL: 45 PERIODS

OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Understand the working principle and characteristics of MOSFET
CO2: Design Combinational Logic Circuits
CO3: Design Sequential Logic Circuits and Clocking systems
CO4: Understand Memory architecture and interconnects
CO5: Design of arithmetic building blocks.

TEXTBOOKS

1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.(Units - I).

REFERENCES

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	2	2	1	3	-	-	-	-	2	3	3	3	3
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	3
3	3	-	3	2	1	2	-	-	-	-	3	2	3	2	3
4	3	3	2	2	2	-	-	-	-	-	-	1	3	3	2
5	2	-	3	2	2	1	-	-	-	-	1	1	3	2	2
C	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**3**

CBM370 WEARABLE DEVICES L T P C
3 0 0 3

OBJECTIVES:

The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

UNIT IV SMART TEXTILE 9

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.
CO2: Explain the energy harvestings in wearable device.
CO3: Use the concepts of BAN in health care.
CO4: Illustrate the concept of smart textile
CO5: Compare the various wearable devices in healthcare system

TEXT BOOKS

1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012

REFERENCES

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1		1
2	3	2	1	1	2			1					1		1
3	3	2	1	1	2			1					1		1
4	3	2	1	1	2			1					1		1
5	3	2	1	1	2			1					1		1
AVg.															

CBM356 MEDICAL INFORMATICS L T P C
3 0 0 3

Preamble:
1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

UNIT III COMPUTERISED PATIENT RECORD 9

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

TOTAL: 45 PERIODS

Course Outcomes:

Upon completion of the course, students will be able to:

- Explain the structure and functional capabilities of Hospital Information System.
- Describe the need of computers in medical imaging and automated clinical laboratory.
- Articulate the functioning of information storage and retrieval in computerized patient record system.
- Apply the suitable decision support system for automated clinical diagnosis.
- Discuss the application of virtual reality and telehealth technology in medical industry.

TEXT BOOKS:

1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata Mcgraw Hill,2005

REFERENCES:

1. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2			1					1	1	1
2	3	2	1	1	2			1					1	1	1
3	3	2	1	1	2			1					1	1	1
4	3	2	1	1	2			1					1	1	1
5	3	2	1	1	2			1					1	1	1
AVg.	3	2	1	1	2			1					1	1	1

OBT355 BIOTECHNOLOGY FOR WASTE MANAGEMENT L T P C

3 0 0 3

UNIT I BIOLOGICAL TREATMENT PROCESS 9

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continous fermentation

UNIT II WASTE BIOMASS AND ITS VALUE ADDITION 9

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

UNIT III BIOCONVERSION OF WASTES TO ENERGY 9

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

UNIT V BIOCOMPOSTING OF ORGANIC WASTES 9

Overview of composting process - Benefitis of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students should be able

1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

TEXT BOOKS

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press
2. Joseph C A., (2019)"Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press,

REFERENCE BOOKS

1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products',The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

OBT356 LIFESTYLE DISEASES L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II CANCER 9

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

UNIT III CARDIOVASCULAR DISEASES 9

Coronoary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

UNIT IV DIABETES AND OBESITY 9

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

UNIT V RESPIRATORY DISEASES 9

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.Kumar&Meenal Kumar, "Guide to Prevention of Lifestyle Diseases", Deep & Deep Publications, 2003
2. Gary Eggar et al, "Lifestyle Medicine", 3rd Edition, Academic Press, 2017

REFERENCES:

1. James M.R, "Lifestyle Medicine", 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, "New Frontiers in Lifestyle-Related Disease", Springer, 2008

OBT357 BIOTECHNOLOGY IN HEALTH CARE L T P C

3 0 0 3

COURSE OBJECTIVES

The aim of this course is to

1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

UNIT I PUBLIC HEALTH 9

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

UNIT II CLINICAL DISEASES 9

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

UNIT III VACCINOLOGY 9

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

UNIT IV OUTPATIENT & IN PATIENT SERVICES 9

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

UNIT V BASICS OF IMAGING MODALITIES 9

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.

REFERENCE BOOKS

1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011

2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

VERTICAL 1: FINTECH AND BLOCK CHAIN

CMG331 FINANCIAL MANAGEMENT LT P C
3 0 0 3

LEARNING OBJECTIVES
1.To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9
Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

UNIT II . **SOURCES OF FINANCE 9**
Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

UNIT III INVESTMENT DECISIONS 9
Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -– Payback -ARR – NPV – IRR –Profitability Index.
Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

UNIT IV FINANCING AND DIVIDEND DECISION 9
Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .
Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

UNIT V WORKING CAPITAL DECISION 9
Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

TOTAL : 45 PERIODS

TEXT BOOKS
1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

REFERENCES .
1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

CMG332 FUNDAMENTALS OF INVESTMENT LT P C
3 0 0 3

OBJECTIVES:

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

UNIT I THE INVESTMENT ENVIRONMENT

The investment decision process, Types of Investments – Commodities, Real Estate and FinancialAssets, the Indian securities market, the market participants and trading of securities, securitymarket indices, sources of financial information, Concept of return and risk, Impact of Taxes andInflationonreturn.

UNIT II FIXED INCOME SECURITIES

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, defaultrisk andcreditrating.

UNIT III APPROACHES TOEQUITYANALYSIS

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

UNIT V INVESTOR PROTECTION

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness andactivism

TOTAL: 45 PERIODS

REFERENCES

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14TH Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5th, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education (India), 11 Edition(SIE), 2019

CMG333 BANKING, FINANCIAL SERVICES AND INSURANCE LT P C
3 0 0 3

OBJECTIVES

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM 9

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

UNIT II MANAGING BANK FUNDS/ PRODUCTS 9

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

UNIT IV FINANCIAL SERVICES 9

Introduction – Need for Financial Services – Financial Services Market in India – NBFC –– Leasing and Hire Purchase –– mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

UNIT V INSURANCE 9

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

TOTAL: 45 PERIODS

REFERENCES :

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS L T P C
3 0 0 3

UNIT I INTRODUCTION TO BLOCKCHAIN 9

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

UNIT II INTRODUCTION TO CRYPTOCURRENCY 9

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

UNIT III ETHEREUM 9

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

UNIT IV WEB3 AND HYPERLEDGE ` 9

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

UNIT V EMERGING TRENDS 9

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

TOTAL : 45 PERIODS

REFERENCE

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madisetti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS LT P C
3 0 0 3

UNIT I CURRENCY EXCHANGE AND PAYMENT 9

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

UNIT III INSURETECH 9

InsurTech Introduction , Business model disruption AI/ML in InsurTech ● IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

UNIT IV PEER TO PEER LENDING 9

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

UNIT V REGULATORY ISSUES 9

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

TOTAL: 45 PERIODS

REFERENCE

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016

4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016

CMG336 INTRODUCTION TO FINTECH LT P C
3 0 0 3

OBJECTIVES:
1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

UNIT I INTRODUCTION 9
Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

UNIT II PAYMENT INDUSTRY 9
FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

UNIT III INSURANCE INDUSTRY 9
FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

UNIT IV FINTECH AROUND THE GLOBE 9
FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

UNIT V FUTURE OF FINTECH 9
How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

TOTAL: 45 PERIODS

REFERENCES
1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018

5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

VERTICAL 2: ENTREPRENEURSHIP

CMG337 FOUNDATIONS OF ENTREPRENERUSHIP **L T P C**
3 0 0 3

Course Objectives

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businessess.
- To empower the learners to run a Technology driven business efficiently and effectively

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entreprenrship to Economic Development.

UNIT II BUSINESS OWNERSHIP & ENVRIONMENT 9

Types of Business Ownership – Buiness Envrionemental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Reosurces Mobilisation-Basics of Managing Finance- Esentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characterisitcis of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportuinites in Technopreneurship - Recent trends

UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -– Success Stories of Technopreneurs - Case Studies

UNIT V EMERGING TRENDS IN ENTREPRENERUSHIP 9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing-Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneruship - NGO Entrepreneurship – Recent Entrperneruial Develoments - Local – National – Global perspectives.

TOTAL45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:
CO 1 Learn the basics of Entrepreneurship
CO 2 Understand the business ownership patterns and evnironment
CO 3 Understand the Job opportunites in Industries relating to Technopreneurship
CO 4 Learn about applications of tehnopreneurship and successful technopreneurs
CO 5 Acquaint with the recent and emerging trends in entrepreneruship

TEXT BOOKS:

1. S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.

2. Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

REFERENCES :

1. Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
2. Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
3. Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
4. David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
5. HarperBusiness,https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf
6. JumpStart: A Technoprenuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
7. Basics of Technoprenuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
8. Journal articles pertaining to Entrepreneurship

CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C
3 0 0 3

COURSE OBJECTIVES

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

UNIT I INTRODUCTION TO MANAGING TEAMS 9

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Devlopment - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9

Team-based Organisations- Leadershp roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

UNIT III INTRODUCTION TO LEADERSHIP 9

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

UNIT IV LEADERSHIP IN ORGANISATIONS 9

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

UNIT V LEADERSHIP EFFECTIVENESS 9

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management -

Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of managing teams for business.

CO 2 Understand developing effective teams for business management.

CO 3 Understand the fundamentals of leadership for running a business.

CO 4 Learn about the importance of leadership for business development.

CO 5 Acquaint with emerging trends in leadership effectiveness for entreprenerus.''

REFERENCES :

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010). 4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

CMG339	CREATIVITY & INNOVATION IN ENTREPRENEURSHIP	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entprerenship.
- To develeop innovative business models for business.

UNIT I CREATIVITY 9

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- - Creative Personality and Motivation.

UNIT II CREATIVE INTELLIGENCE 9

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT III INNOVATION 9

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation-Innovation as Collective Change-Innovation as a system

UNIT IV INNOVATION AND ENTREPRENEURSHIP 9

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours-Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

UNIT V INNOVATIVE BUSINESS MODELS 9

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models –

Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of creativity for developing Entrepreneurship
CO 2 Understand the importance of creative inteligence for business growth
CO 3 Understand the advances through Innovation in Industries
CO 4 Learn about applications of innovation in building successful ventures
CO 5 Acquaint with developing innovative business models to run the business effecientlty and effectively

Suggested Readings:

Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand
Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.
Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
A. Dale Timpe, Creativity, Jaico Publishing House, 2003.
Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT II MARKETING ENVIRONMENT 9

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

UNIT III PRODUCT AND PRICING MANAGEMENT 9

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

UNIT IV PROMOTION AND DISTRIBTUION MANAGEMENT 9

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity -

Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling.

UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

TOTAL 45 : PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to :

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenairos and offer solutions to marketing issues.

REFERENCES:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015.
3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

UNIT I INTRODUCTION TO HRM 9

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

UNIT II HUMAN RESOURCE PLANNING 9

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

UNIT III RECRUITMENT AND SELECTION 9

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

UNIT V CONTROLLING HUMAN RESOURCES 9

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To known about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

REFERENCES

1. Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
2. Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
3. David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
4. R. Wayne Mondy, Human Resource Management, Pearson , 2015.
5. Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
6. John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
7. K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
8. Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

CMG342 FINANCING NEW BUSINESS VENTURES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and quity financing.
- To empower the learners towards fund rasiing for new ventures effectively.

UNIT I ESSENTIALS OF NEW BUSINES VENTURE 9

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

UNIT II INTRODUCTION TO VENTURE FINANCING 9

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Dent and Equity - Challenges and Opportunities.

UNIT III SOURCES OF DEBT FINANCING 9

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

UNIT IV SOURCES OF EQUITY FINANCING 9

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course, the students should be able to:

CO 1 Learn the basics of starting a new business venture.

CO 2 Understand the basics of venture financing.

CO 3 Understand the sources of debt financing.

CO 4 Understanf the sources of equity financing.

CO 5 Acquaint with the methods of fund raising for new business ventures.

REFERENCES :

1. Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education (India) Private Limited, 2018
2. Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hilld Education India Pvt Ltd ,New Delhi , 2019.
3. Introduction to Project Finance. Andrew Fight,Butterworth-Heinemann, 2006.
4. Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
5. Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
6. May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
7. Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
8. Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
9. Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
10. Lerner, Josh; Leamon, Ann; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

VERTICAL 3: PUBLIC ADMINISTRATION

CMG343 PRINCIPLES OF PUBLIC ADMINISTRATION L T P C

3 0 0 3

UNIT-I (9)

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

UNIT-II (9)

1. New Public Administration
2. New Public Management
3. Public and Private Administration

UNIT-III (9)

1. Relationships with Political Science, History and Sociology

2. Classical Approach
3. Scientific Management Approach

UNIT-IV **(9)**
1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

UNIT-V **(9)**
1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

TOTAL: 45 PERIODS

REFERENCEs:

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

CMG344 **CONSTITUTION OF INDIA** **L T P C**
3 0 0 3

UNIT-I **(9)**
1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

UNIT-II **(9)**
1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

UNIT-III **(9)**
1. President
2. Parliament
3. Supreme Court

UNIT-IV **(9)**
1. Governor
2. State Legislature
3. High Court

UNIT-V **(9)**
1. Secularism
2. Social Justice
3. Minority Safeguards

TOTAL: 45 PERIODS

REFERENCES:

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

CMG345 PUBLIC PERSONNEL ADMINISTRATION L T P C 3 0 0 3

UNIT-I (9)

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

UNIT-II (9)

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

UNIT-III (9)

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

UNIT-IV (9)

1. All India Services
2. Service Conditions
3. State Public Service Commission

UNIT-V (9)

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

TOTAL: 45 PERIODS

REFERENCES:

1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations

CMG346 ADMINISTRATIVE THEORIES L T P C 3 0 0 3

UNIT I (9)

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

UNIT II (9)

Theories of Organization: Scientific Management Theory, Classical Model,
Human Relations Theory

UNIT III (9)

Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

UNIT IV (9)

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

UNIT V **(9)**
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

TOTAL: 45 PERIODS

REFERENCES:
1. Crozior M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

CMG347 INDIAN ADMINISTRATIVE SYSTEM L T P C
3 0 0 3

UNIT I **(9)**
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

UNIT II **(9)**
Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

UNIT III **(9)**
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

UNIT IV **(9)**
Coalition politics in India, Integrity and Vigilance in Indian Administration

UNIT V **(9)**
Corruption – Ombudsman, Lok Pal & Lok Ayuktha

TOTAL: 45 PERIODS

REFERENCES:
1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

CMG348 PUBLIC POLICY ADMINISTRATION L T P C
3 0 0 3

UNIT-I **(9)**
Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

UNIT-II **(9)**
Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System’s Approach – Dror’s Optimal Model

UNIT-III **(9)**
Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

UNIT-IV **(9)**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

UNIT-V **(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

TOTAL: 45 PERIODS

REFERENCES:

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

VERTICAL 4: BUSINESS DATA ANALYTICS

CMG349 **STATISTICS FOR MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVE:

- To learn the applications of statistics in business decision making.

UNIT I INTRODUCTION **9**

Basic definitions and rules for probability, Baye‘s theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION **9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS **9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

UNIT IV NON-PARAMETRIC TESTS **9**

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

UNIT V CORRELATION AND REGRESSION **9**

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

TOTAL: 45 PERIODS

OUTCOMES:

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

REFERENCES:

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.

4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

CMG350 DATAMINING FOR BUSINESS INTELLIGENCE L T P C
3 0 0 3

OBJECTIVES :

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

UNIT I INTRODUCTION 9

Data mining, Text mining, Web mining, Data ware house.

UNIT II DATA MINING PROCESS 9

Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures

UNIT III PREDICTION TECHNIQUES 9

Data visualization, Time series – ARIMA, Winter Holts,

UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES 9

Classification, Association, Clustering.

UNIT V MACHINE LEARNING AND AI 9

Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

TOTAL: 45 PERIODS

OUTCOMES:

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

REFERENCES :

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Ïntroduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

CMG351 **HUMAN RESOURCE ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVE:
- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

UNIT I - INTRODUCTION TO HR ANALYTICS **9**
People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

UNIT II - HR ANLYTICS I: RECRUITMENT **9**
Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

UNIT III - HR ANALYTICS - TRAINING AND DEVELOPMENT **9**
Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

UNIT IV - HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION **9**
Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover-grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT **9**
Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity
index - Gender mix

TOTAL: 45 PERIODS

OUTCOME:
- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

REFERENCES:
1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrices, HBR, 2001.

CMG352 MARKETING AND SOCIAL MEDIA WEB ANALYTICS **L T P C**
3 0 0 3

OBJECTIVE:

- To showcase the opportunities that exist today to leverage the power of the web and social media

UNIT I MARKETING ANALYTICS **9**
Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

UNIT II COMMUNITY BUILDING AND MANAGEMENT **9**
History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

UNIT III SOCIAL MEDIA POLICIES AND MEASUREMENTS **9**
Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

UNIT IV WEB ANALYTICS **9**
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

UNIT V SEARCH ANALYTICS **9**
Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

TOTAL: 45 PERIODS

OUTCOME:

- The Learners will understand social media, web and social media analytics and their potential impact.

REFERENCES:

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

CMG353 OPERATION AND SUPPLY CHAIN ANALYTICS **L T P C**
3 0 0 3

OBJECTIVE:

- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

UNIT I INTRODUCTION **9**
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

UNIT II WAREHOUSING DECISIONS **9**
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

UNIT III INVENTORY MANAGEMENT 9

Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

UNIT IV TRANSPORTATION NETWORK MODELS 9

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

UNIT V MCDM MODELS 9

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

TOTAL: 45 PERIODS

OUTCOME:

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

REFERENCES:

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

CMG354 FINANCIAL ANALYTICS L T P C
3 0 0 3

OBJECTIVE:

- This course introduces a core set of modern analytical tools that specifically target finance applications.

UNIT I CORPORATE FINANCE ANALYSIS 9

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

UNIT II FINANCIAL MARKET ANALYSIS 9

Estimation and prediction of risk and return (bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

UNIT III PORTFOLIO ANALYSIS 9

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

UNIT IV TECHNICAL ANALYSIS 9

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

UNIT V CREDIT RISK ANALYSIS 9

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

TOTAL: 45 PERIODS

OUTCOME

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

REFERENCES:

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

UNIT I SUSTAINABLE DEVELOPMENT GOALS 9

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the student is expected to be able to

CO1 Understand the environment sustainability goals at global and Indian scenario.

CO2 Understand risks in development of projects and suggest mitigation measures.

CO3 Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

CO4 Explain Life Cycle Analysis and life cycle cost of construction materials.

CO5 Explain the new technologies for maintenance of infrastructure projects.

REFERENCES:

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, “Sustainable Smart Cities In India: Challenges And Future Perspectives”, SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		1	1		2	3	1	1		2	1	1	2	1
2	3	1	3	2	1	2	2		1	1	1	2	2	2	2
3	2	2	3	1	1	1	1				1	1	1	3	1
4	3	1	3	2	2	1	3	1	1	1	1	2	2	2	2
5	3	1	2	2	2	2	3	1		1	1	2	2	3	2
Avg.	3	1	3	2	2	2	3	1	1	1	1	2	2	3	2

CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9

Ecosystem definition - Biotic *Vs*. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

UNIT III WATER MANAGEMENT 9

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

UNIT IV ENERGY AND WASTE MANAGEMENT 9

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production **-** Goals and components of a community food system - Case studies

TOTAL: 45 PERIODS

OUTCOME

- On completion of the course, the student is expected to be able to

CO1 Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture

CO2 Discuss the sustainable ways in managing soil health, nutrients, pests and diseases

CO3 Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources

CO4 Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas

CO5 Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

REFERENCES:

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		2						2		2			2	2	
2		2		2	2	2							3	2	
3				2		2							3	2	3
4	3	2			2			2	2	2	2		3	2	3
5		2	3	2			1					1		2	
Avg.	3	2	3	2	2	2	1	2	2	2	2	1	3	2	3

1 – Low; 2 – Medium; 3 – High; '- "– No correlation

CES333 SUSTAINABLE BIOMATERIALS L T P C
3 0 0 3

OBJECTIVES

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

UNIT I INTRODUCTION TO BIOMATERIALS 9

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials-Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

UNIT II BIO POLYMERS 9

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials -Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) -Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

UNIT III BIO CERAMICS AND BIOCOMPOSITES 9

General properties- Bio ceramics -Silicate glass - Alumina (Al2O3) -Zirconia (ZrO2)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Compsite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

UNIT IV METALS AS BIOMATERIALS 9

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

UNIT V NANOBIOMATERIALS 9

Meatllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics-BioNEMs -Biosensor**-**Bioimaging/Molecular Imaging**-** challenges and future perspective.

TOTAL: 45 PERIODS

OUTCOMES

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

REFERENCES

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoido Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

CES334 MATERIALS FOR ENERGY SUSTAINABILITY L T P C
3 0 0 3

OBJECTIVES

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

UNIT I SUSTAINABLE ENERGY SOURCES 9

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

UNIT II ELECTROCHEMICAL DEVICES 9

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O_2 battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, $LiCoO_2$, $LiFePO_4$, $LiMn_2O_4$) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

UNIT III FUEL CELLS 9

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

UNIT IV PHOTOVOLTAICS 9

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se_2 solar cells – Cadium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzine – fullerenes - boron subphthalocyanine-tin (II) phthalocyanine)

UNIT V SUPERCAPACITORS 9

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

TOTAL: 45 PERIODS

OUTCOMES

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

REFERENCES

1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

CES335 GREEN TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVE:

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

UNIT I PRINCIPLES OF GREEN CHEMISTRY 9

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

UNIT II POLLUTION TYPES 9

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

UNIT IV DESIGNING GREEN PROCESSES 9

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

UNIT V GREEN NANOTECHNOLOGY 9

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: To understand the principles of green engineering and technology
CO2: To learn about pollution using hazardous chemicals and solvents
CO3: To modify processes and products to make them green and safe.
CO4: To design processes and products using green technology
CO5 – To understand advanced technology in green synthesis

TEXT BOOKS

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008

REFERENCE BOOKS

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS

L T P C
3 0 0 3

OBJECTIVES:

- to understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

UNIT I ENVIRONMENTAL MONITORING AND STANDARDS 9

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS 9

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification-exposure assessment- dose-response assessment; risk characterization.

UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING 9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students will know

CO1	Basic concepts of environmental standards and monitoring.
CO2	the ambient air quality and water quality standards;
CO3	the various instrumental methods and their principles for environmental monitoring
CO4	The significance of environmental standards in monitoring quality and sustainability

	of the environment.
CO5	the various ways of raising environmental awareness among the people.
CO6	Know the standard research methods that are used worldwide for monitoring the environment.

TEXTBOOKS

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soild wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

REFERENCES

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

Course Articulation Matrix

Course Outcomes	Program Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	1	1	1	1	1	-	-	-	1	-	2	2	2	1	1
CO3	1	1	2	1	1	-	-	-	2	-	1	1	1	-	-
CO4	1	2	3	3	1	-	-	-	2	-	3	3	1	-	-
CO5	1	1	3	2	1	-	-	-	3	-	3	1	2	-	-
CO6	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1
Over all	3	2	3	3	2	-	-	-	3	-	3	3	3	1	1

CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

UNIT I ENERGY SCENARIO 9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

UNIT II ENERGY AND ENVIRONMENT 9

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

UNIT III SUSTAINABLE DEVELOPMENT 9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

UNIT IV RENEWABLE ENERGY TECHNOLOGY 9

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar,Bhawana Pathak, R K Kale,"Environment and Sustainable Development" Springer,2016
7. https://www.niti.gov.in/verticals/energy

CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C
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COURSE OBJECTIVES:

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

UNIT I ENERGY AND ENVIRONMENT 9

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

UNIT II ENERGY AUDITING 9

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES 9

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

UNIT V SUSTAINABLE DEVELOPMENT 9

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.